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THE CRISIS IN CHINA. ITS MEANING FOR ENGINEERING INTERESTS.

By Hon. John Barrett, Late U. S. Minister to Siam.

IF there is any one plain fact that stands out with pre-eminent prominence in the present Chinese situation, it is that the material interests of the great industrial nations are identical. In view of immeasurable results, there should be no bickerings, no distrust, and no misunderstanding among such nations as Great Britain, the United States, Germany, France, Japan, and Russia.

Unfortunately, however, selfish considerations, geographical relations, and international jealousies may prevent these leading powers of the world acting in thorough concert and harmony. As corollary, therefore, to the first proposition in regard to community of action among industrial countries, there is no valid reason why Great Britain and the United States, and possibly Japan and Germany, should not unite in forwarding the same policy. If, however, we go on to further elimination, there is absolutely no ground for the United States and Great Britain failing to work together in solving successfully the present Chinese problem.

The preservation of the integrity of the Chinese empire, under autonomous government, is of prime importance to the United States because, as generally recognised, they neither seek nor will accept any Chinese territory under a parcelling out of the Empire. It is no less important to British commercial interests because they have far more to gain from general freedom of trade than from special control of a section of the country—to which other nations would have free access—and restricted or forbidden intercourse with other sections controlled by nations having a less-liberal trade policy.

But beyond all this, larger statesmanship dictates the preservation of Chinese territorial and administrative entity. Division would be only too likely to give rise to bitter and per-

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If there was ever a time in history when the motherland and the ambitious offspring should be united in purpose and action, that time is now in China. Being neither an Anglomaniac nor an Anglophobe, I can make this statement without prejudice. While I am thoroughly convinced that there should be no offensive or defensive alliance between England and the United States in their general relations with the rest of the world, and while I would oppose any formal alliance except in heroic instances, where the life and institutions of the Anglo-Saxon race might be imperilled, I do contend, despite the antagonism of some demagogues and some sensational newspapers, that the interests of the United States and England are almost identical in China.

No man can travel up and down the Asiatic coast from Vladivostock in Siberia and Yokohoma in Japan, to Bangkok in Siam and Batavia in Java, and not be convinced that the commercial and political, or the material and moral, interests of the United States and Great Britain are almost the same. In this matter I speak most frankly and with knowledge of the fact that superficial students of the field and political time-servers may question the truth and wisdom of my observations. This statement, moreover, is submitted with a most friendly feeling towards the policy and purposes of Russia, France, and other countries, which may not commonly be rated as working in harmony with Great Britain. My admiration for the diplomacy of these nations is not in the least limited by my readiness to tell the truth about the relations of British and American merchants and missionaries in all parts of China. Those of us who, either in an official or private capacity, have travelled up and down the China coast from Canton to Tientsin, and back into the interior to Hankow and Chungking, are thoroughly aware that Americans and British, almost without exception, labor along the same lines with harmony of action.

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haps uncontrollable national jealousies and quarrels. And the "white man's burden" is already heavy enough without adding to it the enormous load of the actual direction of the affairs of this huge section of the race. The occidental nations—probably with most helpful intermediary assistance from Japan—must not and cannot shirk the responsibility of inspiring, advising, and to a large degree organising a new and wisely-progressive home government in China. But to the greatest extent possible she should be permitted and led to work out her own new order. Those best informed are most confident of the existence of the necessary elements of stability and progress among the native statesmen of China. The leaven may yet be too feeble of itself to leaven the whole lump, but it needs only fostering care. This, and not the stupendous attempt to raise the mass by outside agency, is the end to which the best efforts of Europe and America should be directed.

Here again, as suggested in an editorial in this issue (p. 899), the engineer—whose interests are greatest—should make his influence felt with his government. Ministers and statesmen have learned to appreciate his importance and to value his advice. It is time for him to learn to appreciate his own power, and to use it.—THE EDITORS.

Let us be fair. If two men think and act alike, why should it not be made known? Why should the truth be covered up for mere political considerations? Whether or not they are brought together because they speak the same language does not determine any different conclusion. The simple fact exists and it cannot be denied. If the marines or sailors from ships of several different nationalities are landed in any Chinese port, you will always find the British and Americans together. Under such circumstances I have repeatedly seen an ardent American-Irishman going about arm in arm with an Englishman or Scotchman, and, if the environment permitted, they would be singing "America" and "God Save the Queen" at the same time! When the Immortalité in Manila Bay saluted the Olympia on August 13, 1898, as the latter, under Admiral Dewey, proceeded to attack the defenses of Manila, I overheard a Fenian Irishman in one of the gun crews of the Olympia call for three cheers for Captain Chichester, of the good British ship. But that is only one instance among a score of others that showed closeness of sympathy in the hour of trouble during the many years that it was my privilege to reside in the Far East. It would be possible to cite illustrations without limit where in Newchwang, Peking, Tientsin, Chefoo, Shanghai, Hankow, Amoy, Foochow, and Canton, American and British merchants, missionaries, and other residents have joined hands to accomplish results and purposes where they had like concern. This did not necessarily involve antipathy for Russians, Frenchmen, and Germans, but, more often than not, caused the representatives of the latter nations to follow the leadership of those of the first two named. At the same time, the most vigorous contentions and debates, which involved the best interests of foreigners, were between Americans and Britishers. They did not unite or disagree simply because they spoke the same language, but because, taking everything into consideration, they had similar interests at stake.

America's supreme concern in China, which appeals to the greatest number of her people, is the commercial opportunity. That is likewise Great Britain's chief concern, and should be that of Germany, France, and Japan. On the other hand, it is doubtless true that Russia's chief ambition is to extend her territorial limits. In time there may evolve a situation where her industrial prosperity will be involved, because Russia must eventually in her development become a manufacturing nation if she would have permanent prosperity. America, it will be admitted the world over, has no desire whatever for territorial aggrandizement. She is on record as being unreserv-

edly opposed to the partition of the empire, to acquiring for herself any port, part, or province of China, and as being committed emphatically to the "open-door" policy. Great Britain is now face to face with a growing sentiment in her own country against any further extension of her imperial domain, and has always led the agitation in favor of the open door. If the war in South Africa would seem to be inspired by a sentiment contradictory to this assertion, it, on the other hand, would appear to mark the limit of conquest which the English people would favor or permit. If any English ministry should now announce a policy of further acquisition of alien lands, its party would probably be defeated if it appealed to the public suffrages. I do not claim to be an authority on English politics, but a study of the current of English opinion would warrant this conclusion. In America the preponderance of unprejudiced opinion is that the United States have taken and are maintaining possession of the Philippines as a result of meeting the unavoidable moral responsibilities growing out of the war with Spain; but the American people would not tolerate for a moment a policy openly in favor of the partition in China or the acquisition of American territory in the limits of Cathay.

Looking candidly into the future, the United States will therefore endeavor, whether in co-operation with Great Britain and other nations or not, to preserve the integrity of the Chinese Empire and prepare the way for a legitimate, untrammelled, material exploitation of China's vast resources. The United States have everything to lose and nothing to gain by the division of China. With China's area intact, America will find markets and opportunities there unrivalled by any yet undeveloped in other parts of the world. Even the most optimistic prophecies of the future of South America and Africa do not rival those that can be reasonably and logically made of China and neighboring portions of Asia. If square miles alone limited the opportunity, this statement might be questioned; but population cuts even a more important figure than area. Millions of people are what make the demand for the manufactured and agricultural products of America and Europe. The population of Asia, moreover, is increasing rapidly, and the more the inhabitants come into contact with the wares of the outer world, the greater grows their demand. The improvement of China's latent mineral resources, of her wide agricultural extent, of her rivers, canals, and harbors, of her city and country conditions, and of her transportation facilities, would be easily measured, but not so inviting, if within the mighty reach of the empire were not uncounted millions of inhabitants.

While it is admitted that the supreme concern of the English-speaking peoples is commercial opportunity, it cannot be out of place, even in a technical magazine, to acknowledge that next to that, or almost rivalling it, is the moral responsibility. Our missionaries have prepared the way for our merchants. For long years the forward movement of Christianity has contended for a betterment of the people. And an extended experience with the missionaries in Siam, who were under my jurisdiction as United States minister, and considerable acquaintance with them in China, Japan, and other lands, gained by travel, have convinced me that our missionary and mercantile interests should work together for the advancement of both foreign and native welfare in the Chinese Empire. It is useless to discuss a new situation in China, where our merchants shall have unlimited privileges and our missionaries shall be curtailed. The missionary societies and chambers of commerce in Great Britain, the United States, and in other Christian countries, should unitedly support their respective governments in insisting upon a re-adjustment of affairs in China, where the rights, lives, work, and property of all will be safeguarded. Let us stand for an "open door" where the engineer and the educator, the merchant and the missionary, can enter without discrimination in favor of one over the other. Then church and commerce will make an irresistible moral and material force that will lead the way to a social and trade development in China which will astonish the world and meet the approval of both white and yellow races.

The present crisis in China induces us to study her people and resources as never before. In striving to ascertain real facts, conservative experts are making their predictions on other grounds than those of imagination. In this connection it is well to emphasize the opinion of many authorities that China's reputed population of 402,000,000 is a limit not warranted by the observations of observing travelers. General William Barclay Parsons, the noted American engineer who went overland from Hankow to Canton and made other excursions into the interior, stoutly contends that there are not more than 250,000,000 people in China. Dr. Morrison, who crossed from the Yangtsze Valley through Yunnan into Siam, holds that the population is exaggerated. Mr. Archibald Colquhoun, who is possibly the ablest living authority on China, has often told me that he did not think that the empire comprehended the figures commonly stated. Mr. W. Pritchard Morgan's engineers, who have recently visited Szechuan, the principal province of China in area and population,

state that the estimate of inhabitants should be cut in twain. Missionaries and others who lived long in Peking and in Canton, after comparing the density of population to that of many European and American cities, agree that the large figures usually given are greatly exaggerated. In my own travels, I have never been convinced that China could possibly have over 300,000,000 people. If it is granted, however, that 300,000,000 Chinese occupy her 4,000,000 square miles, and that they are increasing in a natural ratio, the European and American engineers and merchants have before them an opportunity worthy of their best efforts.

The most striking and impressive consideration is that of possible railway construction. These millions must be carried hither and thither, these boundless miles must be connected by trunk and branch lines, the products and wealth of the interior must be brought to the coast, and the imports of foreign countries must be shipped to inland points with the aid of modern facilities for mechanical transport. A picture of railway extension in China, based on possible passenger and freight traffic, cannot yet be accurately painted, but it is a reasonable estimate that China should require in the near future 40,000 miles of railways, instead of 400 miles, as now. If not over 4,000 miles are at the moment planned or contemplated, that is no argument that ten times as much building will not be needed when systematic construction is once begun and the government and the people are favorably disposed to this radical innovation. Against dire prophecies of the financial failure of the Tientsin-Peking line, it has prospered beyond the expectations of all. The fact that in certain parts of the empire some tracks have been torn up, or that fanatical fury has opposed construction, proves nothing against eventual possibilities.

Then follows, in importance, the improvement of the rivers, canals, and harbors. Few countries in the world offer such possibilities as China in this respect. The best engineering skill of England and America will have a field here of supreme effort. Millions of dollars must be expended, and a long time occupied, in opening up the grand canal from Chinkiang on the Yangtsze to Tientsin on the Peiho; the difficult problem of keeping within its channel the frequent floods of the mighty Yellow River, or Hoang Ho, must be met and solved in the near future, if the lives of millions of people are to be saved and a rich area protected from famine and devastation; the numerous obstructions in the course of the great Yangtsze artery must be removed and navigation protected throughout the year for the obvious advantage to local and foreign trade; the lesser water-

ways, like those of the Sekiang in the south and the Peiho in the north, must be made safe for the regular coming and going of river and coast craft; the harbors and their entrances at Shanghai, Taku, Newchwang and other similar points must be deprived of their "heaven-sent barriers"; roads and highways must be constructed in the neighborhood of the chief cities and into the interior; bridges of modern style and strength must be placed across rivers and canals; the many populous cities must be supplied with electric lights, with water works, with sewerage systems, and their streets must be widened and other corresponding engineering changes instituted: the same cities must be provided and connected with electric car lines; telephones and telegraphs must be extended; mines of coal, iron, copper, gold, and other minerals and metals, known to exist in large and paying quantities, must be opened and worked and their products brought to interior and coast markets; methods of agriculture must be changed to the demands of new conditions; the old style of construction of business buildings, home dwellings, warehouses, and other structures must give way to modern architectural materials.

This is not a fanciful picture. Such evolution from the old to the new is going on with astonishing rapidity in Japan, Siam, India, Egypt, the Straits Settlements, Java, the Philippines, and it will surely come in due time throughout the Chinese Empire. What can be done when a country once moves is supremely well shown in Japan, but I was particularly impressed with the record of Siam during the four years of my residence as United States minister there. In 1898 I saw marvelous changes along the lines summarized above in regard to China which I did not imagine could be accomplished when I first went there in 1894. When we remember that Japan fifty years ago was essentially in the same material state that it had been for three thousand years before, it is not unreasonable to expect a similar advancement in China when the interior shall be opened, a more liberal and progressive administration of law and order inaugurated, and the nations of the foreign world have united to preserve the integrity of the empire and promote necessary reforms. Japan has developed her foreign trade from $30,000,000 to nearly $300,000,000, in approximately thirty years. China's trade is now valued at $333,000,000. This is an increase of 100 per cent. over the figures of ten years ago and 33 1-3 per cent. over the condition in 1898. It would seem, therefore, as if China were beginning to extend her commerce to such figures as would eventually correspond with those of Japan in proportion of trade to population. If this comparison were strictly car-

ried out and Japan's ratio of trade, $7 per head, were applied to China, on a basis of 300,000,000 people, she would have in due course of time the magnificent annual total of $2,100,000,000. This may not be realized for some decades to come, but it must be reached eventually. When we remember that Great Britain's foreign trade averages nearly £20* ($100) per head, and that China's population and demands are rapidly increasing, it is not unreasonable to estimate her future possibilities on a basis of $7 per head. America in 1899 sold to and bought of China, including Hong Kong, products valued at nearly $45,000,000. It is not an exaggeration to state that this total should grow to $450,000,000 in fifty years. A careful examination of the customs returns of China for 1899 shows a remarkable increase along those lines which mean much for a diversified development of manufacturing and agricultural exports from all parts of the world. And from America, the manufactured cotton goods of the southern States, the flour of the Pacific coast and the northwest, the petroleum of the middle States, and the manufactured iron and steel and miscellaneous output of the central west and of the eastern States are finding a widening market in China, and yet the opportunity is in its infancy.

What applies to the United States is also true in corresponding measure of the demand for the products of the industrial countries of Europe, so that they can work in common for the preservation of the Empire's entity and the permanent maintenance of the open door.

Summed up in a few words, therefore, the policy of the United States, supported by engineers, merchants, missionaries, manufacturers, capitalists, and laborers, as well as by diplomatists and statesmen, should include: first, the re-establishment of peace, order, contentment, and prosperity throughout the entire empire, with just reparation for loss of life and property sustained at the hands of the insurrectionary forces; second, the permanent protection of the lives, rights, and interests of foreigners as laid down in the treaties with China; third, the maintenance of Chinese sovereignty throughout an unpartitioned area from Manchuria to the Kwangs and from Chekiang to Thibet; fourth, the lasting practical application in both letter and spirit of the open-door trade principles as laid down in the conventions between China and the foreign powers. If the United States and Great Britain will employ their united moral influence for the achievement of these results and not weaken in any point, they will be supported by Japan, and not opposed by Germany, Russia, and France.

* Calculated from the total export and import trade. The former is approximately 2-5 and the latter 3-5 of the total.

THE FOURTH ERA OF THE LEADVILLE MINING DISTRICT.

By Thomas Tonge.

LEADVILLE is unquestionably the most important mining district in Colorado when judged by its aggregate production during the last twenty-one years, which has exceeded $250,000,000 worth of ore, by its present great tonnage output, and by its certain vast future production for the next fifty years and more.

Its special characteristics are that the great mines opened within the last few years, both in gold and silver, were discovered and operated by Leadville men and by the expenditure of Leadville or Colorado money—by men who had studied and knew the district and its possibilities, and who had the energy and courage of their convictions. Moreover, the questionable practices of "promotion" and "flotation" are practically unknown; not a single Leadville mine is listed on any stock exchange, and nothing but the ore taken from the ground is looked to for profits. High salaries and expensive offices are avoided and efficient and economical management is the rule. In this way Leadville presents numerous instances of ideal mining, which some other districts could well copy.

Leadville has now entered on a fourth era in its history: The first era was that of placer mining in California Gulch from 1859 to 1869, which attracted many thousands of persons, and during which period millions of dollars' worth of gold were taken out, not included in the $250,000,000 before mentioned. The placer era was succeeded by a period of innocuous desuetude from 1869 to 1879 and by the partial abandonment of the district.

The second era commenced with the discovery, about 1879, of rich lead-carbonate ores running high in silver. This led to the opening up of the wonderfully productive mines on Iron Hill, Carbonate Hill, Fryer Hill, etc., some of which paid millions of dollars in dividends. During this carbonate period thousands of persons

flocked to Leadville from the ends of the earth, and millionaires were made almost in a day. The rich carbonate ore deposits, found comparatively near the surface, are now practically exhausted.

The third era dates from the decline in the price of silver, culminating in 1893 with the closing of the Indian mints to the coinage of silver, and the repeal of the silver purchasing clauses of the Sherman act. In the words of Mr. A. A. Blow, M. E., the mining industry of Leadville was seriously crippled, her prestige apparently lost, and the district received a check which even the most sanguine could not help admitting was a case of partial paralysis, with a serious prospect of a total annihilation of her only industry. Silver was then supposed to be her only hope and salvation, and the fall of the white metal was thought by many to be the signal for Leadville's rapid decay and abandonment. The period of depression, however, only served to turn a new page in Leadville's history and to usher in the third or golden era of this wonderful mining district, in the opening up of what is known as the Leadville gold belt, two miles east of the city and embracing Breece Hill, Printer Boy Hill, Florence Hill, and Little Ellen Hill—an area of about four square miles.

BREECE HILL.

The glamour of the wonderful discoveries of the rich carbonate ores in 1879 and subsequent years practically obscured the fame of the gold-placer workings of 1859-1864, which were simply remembered by the older inhabitants as a departed glory and were regarded by some of the new comers almost in the light of a tradition. The decline in the value of silver set some of the practical men to theoris-

ing as to the probable source of the gold originally found in the placers of California Gulch, and directed renewed effort to the exploration of the gold-bearing area.

While what is now known as the gold belt on Breece and other hills has been worked on a small scale ever since 1879, it was not worked so vigorously as that portion of the district consisting of

GENERAL VIEW OF LEADVILLE.

Fryer, Carbonate, and Iron Hills, simply because the outcrops of the main veins were more disturbed and altered by atmospheric agencies. On the three hills mentioned the ore was found intact at no great distance from the outcrop, while on Breece Hill the vein had been leached of its valuable contents for a considerable distance. Many attempts were made to reach pay ore in quantity in that vicinity, but the first successful attempt was as follows:

Mr. John F. Campion, a practical mining man of considerable local experience, theorised that while the faults of the Leadville district interrupt its known ore bodies temporarily, or displace them, the ore bodies do not thereby terminate, but are continued beyond such faults at other and different horizontal planes. Acting on this theory he commenced exploration work on Breece Hill in 1891, in a shaft now a part of the property of the Ibex Mining Co. He began work himself by taking a lease, with option of purchase, and afterwards admitted some personal friends as partners, the partnership being organised and known as the Ibex Mining Co., with a capital of $100,000. The company is still a close corporation. Pay ore was discovered in August, 1892, but not in large quantities. After further exploration it was concluded that the main ore bodies were deeper and the shaft was sunk another 150 feet, in some places through dolo-

THE PROPERTY OF THE IBEX MINING COMPANY.

mite sand or lime quicksand, a most difficult, treacherous, and expensive material to pass through. It required two years of steady expense and of the exhibition of the courage born of knowledge before the main ore body was reached, in 1893, since which time the property has produced $13,000,000.

The success of the Ibex Mining Co. led to much development work on Breece and adjoining hills, and a brief mention of the most easterly mine is justified, particularly as the same geological formation evidently continues still further easterly to and beyond the summit of the Mosquito Range or Continental Divide.

The Resurrection Gold Mining Co. is also a close corporation, composed of three Colorado men and capitalised at $500,000. The company owns 240 acres of patented ground on Little Ellen Hill, of which as yet only 33 acres have been opened up. The property was acquired in 1894, since which the following shipments have been made: 1895, 5,000 tons; 1896, 9,000 tons; 1897, 16,000 tons; 1898, 24,000 tons; 1899, 36,000 tons; while if the present rate of output is maintained, there will be 45,000 tons of ore shipped during the current year. The ore has averaged in value $20.27 per ton, 50 per cent. of the value being contributed by the gold, 32 per cent. by the lead, and 18 per cent. by the silver.

According to the statistics of the United States mint, the annual

gold output of Leadville has risen from $262,629 in 1892 to $2,183,332 in 1899; each succeeding year will witness marked further advance.

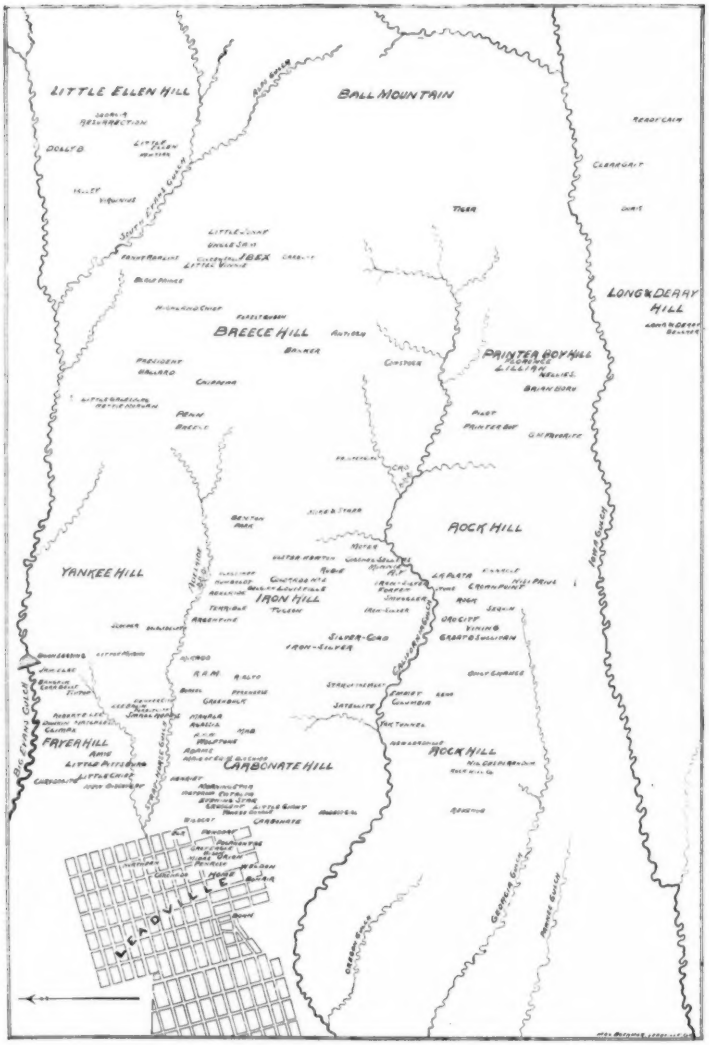
The fourth era may be called the composite era, in which gold, silver, lead, copper, iron, zinc, and bismuth are profitably mined and treated.

Almost simultaneously with the development at the eastern end of the district commenced the development of what is known as the "down-town" section, towards the western end of the district, followed by other work on Rock Hill on the southwesterly continuation of the known ore chutes of Iron Hill. The development of the down-town district dates from about 1890, with the sinking of the Sixth Street shaft, followed by the sinking of the Penrose, Elk, Bon Air, Hussey and Bohn shafts, ranging from 500 to 550 feet deep, all revealing the

NO. 3 SHAFT, RESURRECTION GOLD-MINING CO.

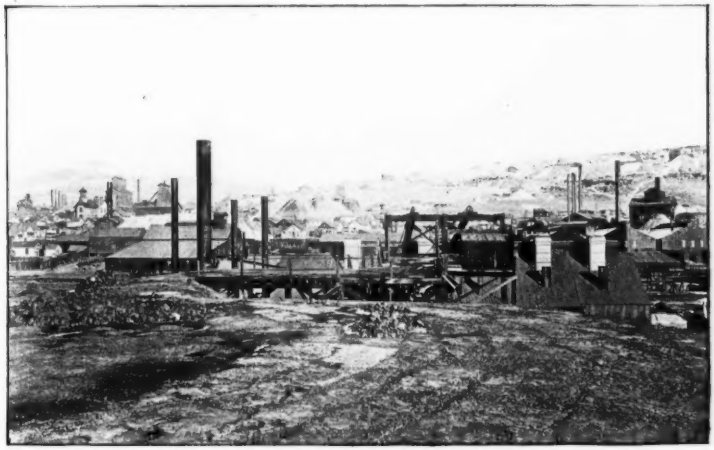
continuation in a southwesterly direction of the characteristic Leadville formation, which yielded such large quantities of rich carbonate ore in Carbonate, Fryer, and Iron Hills. The ores of the down-town district—and, in fact, the bulk of the present output of Leadville, outside the gold belt—consist of iron and lead sulphides carrying silver and more or less zinc, and of iron oxides carrying silver.

Several of the down-town shafts had shipped considerable ore prior to 1893, when the fall in the price of silver and lead caused a cessation of operations. Just as the district was beginning to recover from the effects of the events of 1893 and to adapt itself to the new conditions, serious labour troubles took place in 1896 in the form of a strike of the miners, during which the mines were closed, pumping ceased, and the workings became filled with water. In 1898 a pump-



MAP OF THE LEADVILLE MINERAL DISTRICT.
By Max Boehmer, Leadville.

ing association was formed by the owners of about twenty of the down-town mining properties, and pumping was begun in the fall of 1898. The main pumps were installed in the Penrose and Bon Air shafts, while existing pumps in the Bohn, Northern, and Coronado shafts co-operated. For quite a number of months an aggregate of 4,000 gallons per minute were raised, the entire operation costing more than $100,000. After the district was once drained the pumping became normal, viz., about 1,200 gallons per minute, to the cost of which each member of the pumping association contributes rateably, based on the value of the ore taken out monthly. This down-town section is now producing nearly 20,000 tons per month, yielding a minimum profit of $5 per ton after mining and smelting.



Penrose. Bohn. Starr. Weldon. Bon Air.

THE DOWN TOWN PROPERTIES.

Space does not admit of a detailed statement as to the exact geology of the various parts of the Leadville district, which has been exhaustively dealt with by Professor Hayden, Professor Emmons, and others, and to-day is practically an open book. Speaking generally and of that part of the district known as the Leadville Basin, the rocks lie flat and the ore is found in blanket veins. The rocks occur in the following order: directly under the wash and nearest the surface is the white porphyry; next comes the limestone, then quartzite, then granite. The largest bodies of ore are found in chutes or channels having a northeasterly and southwesterly direction, lying on the planes of contact or stratification of the different rocks, and often

to a large extent replacing the rocks themselves. No work on any ore channel in either direction has ever shown its end. It is not unusual to find the ore bodies of great thickness and extent. For instance, at one time in the A. Y. & Minnie Mine, on Iron Hill, a solid body of ore, free from waste, was blocked out 941 feet long, 176 feet wide, with an average thickness of 67 feet, such ore averaging 48 ounces of silver per ton and 15 per cent. lead.

The ore channels, as a rule, have well defined boundaries or walls laterally. Longitudinally they have been followed for lengths up to 6,000 feet. A new discovery of a channel in virgin ground in Leadville generally means a great discovery, and persons making such realise very handsome returns.

NO. 2 SHAFT, RESURRECTION GOLD-MINING CO. ALTITUDE, 11,700 FEET.

At the extreme eastern end of the present developed district No. 2 shaft of the Resurrection Mine passed through the following strata: 400 feet Webber grit, 150 feet Webber shale, 100 feet white porphyry, 125 feet blue limestone, 25 feet parting quartzite, then white limestone. The ore was struck at 650 feet from the surface, just below the white porphyry and above the blue limestone, and again in the white limestone beneath the parting quartzite. On Carbonate Hill and Iron Hill the Webber grit and shale have been eroded.

The gold-bearing ores on the gold belt are in continuation of the same ore bodies previously discovered further west, and are a part of the system in which ore chutes have evidently been enriched in their gold contents by the influence of the porphyry dykes. The ores of the gold belt are found at the contact plane of the blue limestone with the eruptive rocks and in lower horizons of the limestone and also in

the porphyry dykes. The ores in the gold belt consist of silicious ores, carrying gold and silver, and a small percentage of lead and sulphide ores, also carrying a small percentage of copper.

At the extreme westerly end of the present developed district, Revenue Shaft No. 1, when I was there on May 11, was down 621 feet, having passed through the following strata: "wash" and "lake bed," 325 feet; white porphyry, 220 feet; contact, 6 feet; blue lime, 20 feet; gray porphyry, 50 feet. It was then expected that possibly another 100 feet of gray porphyry would be encountered, to be succeeded by blue lime. On this point, one of the leading local mining experts, Mr. Max Boehmer, M. E., says: "In many places ore is found beneath a sheet of gray porphyry, which lies near the middle of the blue limestone," and the gray porphyry in the Revenue shaft was regarded as such an intrusive sheet in the blue limestone.

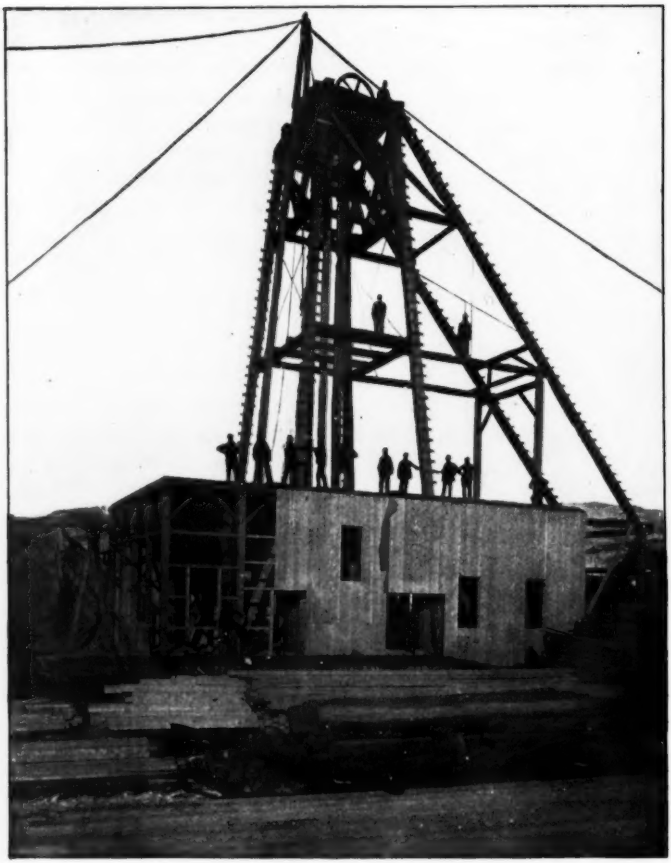
The Leadville of to-day is entirely different from the Leadville of twenty years ago, or even of ten years ago. While in 1880 the mining operations were practically confined to Carbonate, Iron, and Fryer Hills, at the present time the mines extend from the Resurrection on Little Ellen Hill on the east, to the Revenue on West Rock Hill on the west, a distance of seven miles, with every indication that further development both east and west will encounter similar ore bodies.

Since 1880, and particularly since 1890, the problem of handling the low-grade ores has been very successfully solved, and the result is an enormous increase in the tonnage output, which ten years ago did not exceed in the average 1,400 tons daily, as against an average of more than 3,000 tons to-day. The change has been brought about by various causes operating in the direction of increased economy; the chief of these may be summarised as follows:

(1) In 1880 the average smelting charge was $30 per ton, in 1890 $10 per ton, while at the present time it is about $5 per ton.

In 1880 the Leadville smelters had small furnaces, each of a daily capacity of 30 to 35 tons, with low blast, short flues, low stacks, and no devices for settling the slag. The short flues and low stacks involved great loss of values in dust and fumes. Moreover, the chemical mixtures in the furnace were not then as well understood as now. For the above reasons it was not then possible to make a clean saving of the values. At the present time the smelter furnaces have each a daily capacity of from 100 to 150 tons, with high blast, long flues, and high stacks, preventing loss of values in dust and fumes, with additional devices looking to increased saving in values, by means of all of which the former losses in value have been reduced considerably

more than 50 per cent. The smelter dumps accumulated prior to 1890 have since been more or less re-smelted at a profit.

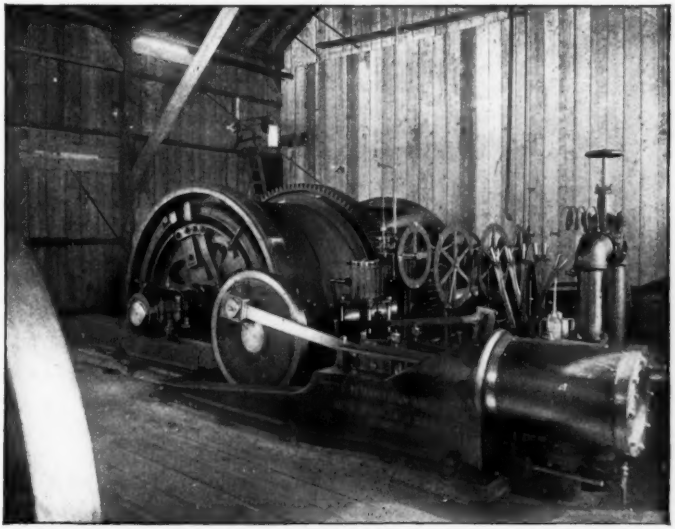


WOLFE TONE SHAFT, A. M. W. MINING CO.

The fuel used by the Leadville smelters in 1880 was charcoal of local production, and coke, hauled from Pennsylvania to the nearest railroad point and from thence by wagon to Leadville. The smelters now obtain coke in unlimited quantities from Colorado ovens at a tithe of the former cost of Pennsylvania coke, while charcoal is largely dispensed with. The cost of iron, fire brick, and other smelter supplies has also been proportionately reduced.

(2) The cost of steam coal in Leadville to-day shows a reduction of 75 per cent., as compared with 1880, and of 50 per cent., as compared with 1890.

(3) Leadville is essentially "a wet camp." The cost of pumping has been much reduced owing to the improvements in pumps. Formerly ordinary single or duplex pumps were used, with a capacity of 150 to 400 gallons per minute, whereas to-day compound and triple-expansion pumps, some of them with a capacity as great as 1,500 gallons per minute, are the rule. The cost of pumping has thereby been reduced 50 per cent.



STEAM HOISTING PLANT FOR 1,200 FEET.
Little Johnny, Ibex Mining Co.

(4) Since 1880 the freight rate on ores from the Leadville mines to the smelters at Denver and Pueblo has been reduced considerably more than 50 per cent., some of which reduction took place since 1890.

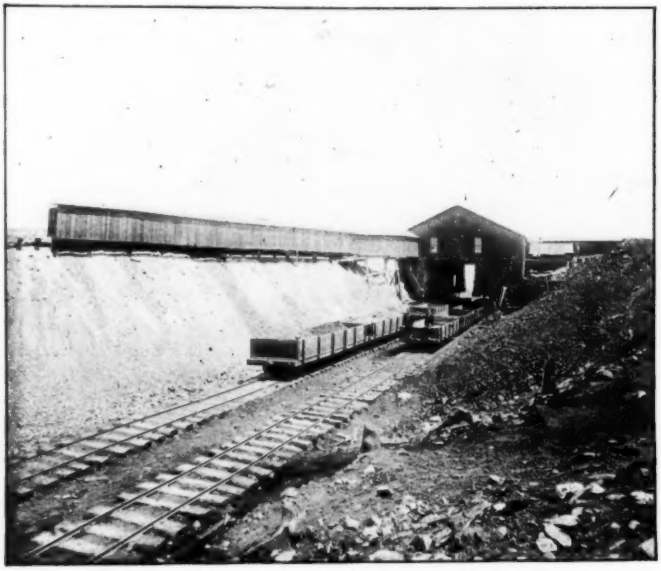
(5) Freight from the mines to Leadville smelters via the various local railroad spurs, as compared with cost of previous wagon haul, has been reduced more than 50 per cent. within the last two years.

(6) The cost of explosives, candles, and other mine supplies during the last twenty years has been reduced more than 50 per cent., a part of such reduction having taken place during the last ten years.

These things have brought within the range of profitable produc-

tion an immense tonnage of ore which formerly could not be touched. In 1890, while the sulphide bodies were more or less opened up, only the very best grades could be mined, owing to the heavy smelting and other charges then prevailing. Neither the gold-belt nor the down-town mines were producers in 1890. Since that time, as above shown, radical reductions in cost of mining and treatment have so changed the conditions that sulphide ore, which could not be handled profitably when silver was 80 cents per ounce, yielded a profit several years later, when silver had dropped to 60 cents per ounce, and ores which were commercially valueless a decade ago now yield a steady margin of profit.

The easy-going and carelessly extravagant ways of 1880 and subsequent years have also been succeeded by an era of experienced, judicious, and rigidly economical management, to the great advantage of the mine owner and investor. There is no place in the United States where mining has been brought down to a more scientific and



RAILROAD SWITCH AT THE NO. 2 SHAFT, RESURRECTION GOLD-MINING CO.

economical basis than it has at Leadville. The low cost of production at some mines is simply phenomenal. For instance, one company (a close corporation of several Leadville men, capitalised at $100,000)

during 1899 mined and placed on the cars more than 50,000 tons of ore at an average cost of $3.16 per ton, and has paid $200,000 in dividends since September, 1898.

A considerable quantity of low grade ore is mined simply for fluxing purposes and its low value has necessitated the most economical operation. As above shown, the fall in the price of silver has been more or less compensated for by subsequent improved, modern, economical appliances in both mining and ore treatment, reduced freights, etc.

BIMETALLIC SMELTER.

Leadville is well equipped with smelting facilities. The American Smelting & Refining Co. has three first-class plants at Leadville, viz., the Arkansas Valley Smelter, with a capacity of 20,000 tons of ore per month; the Union Smelter, with a capacity of 5,000 tons of ore per month, both using lead as the collecting medium, and the Bimetallic Smelter, with a capacity of 10,000 tons per month, with the largest cupola pyritic stack in the world, producing copper matte. These smelters furnish employment for between 800 and 900 men. About 50 per cent. of the local ore is treated at these plants, the other 50 per cent. being shipped by railroad to the smelters at Denver, Pueblo, Durango, and even Salt Lake City, as a desirable mix with other characters of ore.

Another important factor in the recent development of the district has been the building of many miles of track by the Denver & Rio Grande Railroad and the Colorado Southern Railroad throughout the district, reaching almost every important mine and thus dispensing with expensive wagon haul over steep and rough mountain roads. The fact that many of the mines can now empty the ore from the mine cars directly into the railroad cars for shipment to the smelters, and the resulting reduction of cost of freight, has alone brought

within the range of profitable production large bodies of low-grade ores which formerly were left untouched.

A special feature of the last few years has been the organisation of close corporation companies by Leadville men of local mining experience, with their own capital, for the leasing and operating of properties, subject to royalties. They have been phenomenally successful financially, largely by reason of competent and experienced management.

From twenty-five to thirty of the Leadville mines produce more or less manganiferous ore, in the form of oxide of manganese, the ore running about 33 per cent. manganese. When this ore contains sufficient silver to pay it is shipped to the local smelters; when deficient in or absolutely without silver it is shipped to the steel works for use in the manufacture of Bessemer steel. The Colorado Fuel & Iron Co. in its steel works at Pueblo uses about 25,000 tons per annum of these Leadville manganese ores for making spiegel. In 1897 35,000 tons of these ores were shipped from Leadville to the Illinois steel works at South Chicago, Ill., a distance of over 1,100 miles, and similar large quantities have since been shipped annually.

Some of the Leadville mines have always produced more or less zinciferous ores, which involved such comparatively high treatment charges at the smelters as to make them unprofitable. At the A. Y.

THE ARKANSAS VALLEY SMELTER.

& Minnie Mine, to avoid this difficulty, in former years the ore was crushed and the zinc contents separated from the silver-lead contents by means of jigs. As the zinc tailings could not be allowed to choke the adjoining stream, the then unmarketable article was impounded until a dump of 150,000 tons had accumulated. In the early part of 1899, when zinc was over 6 cents per pound, a shipment of crude zinciferous ore from the Moyer Mine at Leadville was made to Belgium, via Galveston, followed by others, several thousand tons being so shipped during last year.

In October, 1899, two mills, one a stamp mill and the other a roller mill, each of the capacity of 30 tons, were equipped with Wilfley separating tables and commenced to treat zinciferous ores running from 30 to 35 per cent. zinc, 8 to 14 per cent. lead, and from 4 to 6 ounces of silver. The Wilfley table is the first appliance to separate such ores successfully, there being two products, (1) the zinc, (2) the lead, silver, and iron. The lead, silver, and iron product goes to the Leadville smelters, where it is very desirable for flux. From October, 1899, to April 1, 1900, these two mills produced 7,500 tons of separated zinc ore, about two-thirds of which were shipped to Belgium, via Galveston, some to the zinc works at Iola, Kan., Mineral Point, Wis., and to Indiana. The purchasers of the zinc do not pay for the small gold and silver values contained therein. It has not yet been absolutely demonstrated whether the stamp mill or the crushing roll is most suited for this ore. In the meantime a trial lot of 300 tons from the old zinc tailing dump of the A. Y. & Minnie Mine has been purchased for zinc works in Canada, with possibility of the entire dump being also purchased if the experiment is a success. As there are probably 1,000,000 tons of zinc ores now in sight in Leadville, in the form either of zinc tailings from former mills or of crude ore formerly regarded as waste, now in the dumps of the old properties, or in place in the underground workings ready for stoping, the indications are that the question of the profitable mining and treatment of the zinc ores of the district will be satisfactorily solved in the near future.

Another recent product of Leadville is ore carrying about two ounces in gold per ton and a high percentage of bismuth. The ores of a number of the mines in the gold belt carry more or less bismuth, which the Colorado smelters have no means of saving. In one mine, however, the percentage of bismuth is sufficiently high to justify shipping to Europe. Small shipments were made last year, and in April, 1900, two shipments, aggregating 40 tons, were made to reduc-

tion works in England, specially equipped for extracting the full values from such ores. Further shipments are about to be made.

For 1899 Hon. George E. Roberts, Director of the U. S. Mint, credits Leadville with an output of gold, $2,183,332; silver (coinage value), $9,383,918; lead, $2,174,876, and copper, $1,228,463, or a total of $14,970,589, to which must be added probably about $600,000 for zinc, manganese, and bismuth. All these figures will be materially increased for the current year.

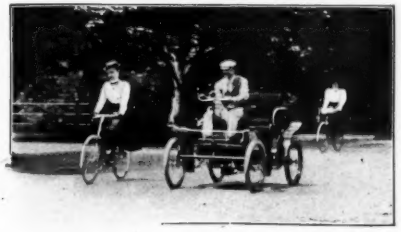
To-day there are over 4,000 miners at work in and around Leadville, the daily output of ore exceeds 3,000 tons, the average value of which ranges from $10 to $20 per ton, this average being materially lowered by the large quantity of low-grade iron ore absolutely necessary as a smelting flux, which low-grade ore nets from $3 to $6 per ton from the smelter. Every ton of ore, however, shows a steady margin of profit and the great tonnage represents large sums.

Notwithstanding its past great production, the district is as yet only in its infancy. It is capable of indefinite expansion, as the local ore-bearing geological formation extends beyond the Resurrection Mine easterly into Park County, on the eastern slope of the Mosquito Range, the Continental Divide, and westerly beyond the Revenue Shaft on West Rock Hill to the Arkansas River, constituting an ore zone at least 20 miles long and several miles wide. Outside the above mentioned belt, and within a few miles of Leadville there is land still belonging to the Government, and therefore obtainable on the usual nominal terms, in which, with capital, gold and silver ore in paying quantities could practically be guaranteed. To prospect such ground, however, requires courage and money, while if pumping is involved the cost is indefinitely increased. The expansion development, therefore, proceeds somewhat slowly, but in no mining district of the western States are the results of intelligent, judicious development work so sure.

It is only a matter of time when development work will extend beyond the present east and west termini of the shipping zone, while within the present ore-shipping district are considerable areas, more particularly south of California Gulch, as far as Empire Gulch, and in the down-town district and under the very town itself, where shafts now being sunk are morally certain to encounter the continuation of the known ore channels. The permanency of Leadville is absolutely assured, and all present indications are that there will be profitable mining in the Leadville district a hundred years hence.

HEAVY MOTOR VEHICLES FOR ROAD SERVICE.

By Fred W. Maynard.



IN America and on the Continent engineers have confined themselves almost exclusively to the construction of the lighter passenger cars, but in England the heavier type of auto-waggon has received the greater attention. It has not, however, been until the closing years of the nineteenth century that practical success in the manufacture of these self-propelled freight vehicles has been attained. This undoubtedly is in great measure due to restrictive legislation, and in earlier times to the rudimentary condition of the engineering industry, the imperfect state of the roads, and hostile public opinion as represented by the land-owning and horse-breeding classes.

The general design of the most notable steam vehicles at present on the English market will be seen, from the illustrations provided, to differ very considerably. Experience is gradually shewing the necessity of economy and simplicity in constructional details, for whereas some of the vehicles contain air condensers fitted with elaborate radiating arrangements, air-circulating fans, induced draught fans, and various engine, boiler and other refinements, with attendant complications, in the more successful types a steady progress towards fewness and simplicity of parts, availability of the motor for various employments, ready accessibility, durability of construction and centralisation of controlling arrangements, is becoming more and more manifest. My former paper summarised the general principles of construction characterising the best accepted practise. It remains to consider more specifically the vehicles put upon the market by the leading makers of Great Britain.

The extreme length of the drays ranges from a little under 16 feet to slightly over 18 feet, the platform area available for loading varying from 56 to 71 square feet, according to the disposition of the

Mr. Maynard's first article appeared in THE ENGINEERING MAGAZINE for August, 1900.

THORNYCROFT STEAM VAN AS USED BY THE STRAND BOARD OF WORKS.

boiler and machinery; the extreme width is limited by the English law to 6 feet 6 inches. The framing is almost without exception of channel steel; the wheels are either of the military type, with metal naves, oak spokes, and ash felloes, or are built up entirely of iron or steel; the latter are, however, not to be recommended, the jars to which they are continuously subjected soon shaking them to pieces, a metal wheel naturally not possessing the same resiliency as one in which wood forms an integral part. As one firm of builders has made a specialty of "dished" wheels for their motor vehicles, it will not be amiss to state that in an excellent article which recently appeared in the *Automotor*, Mr. H. E. Wimperis, Wh. Sc., clearly demonstrates that, however great their advantages may be for the rolling wheels of horse-drawn vehicles, this system of construction is quite unsuitable for the driving wheels of motor-waggons, in which the strains and stresses are of an entirely different character.

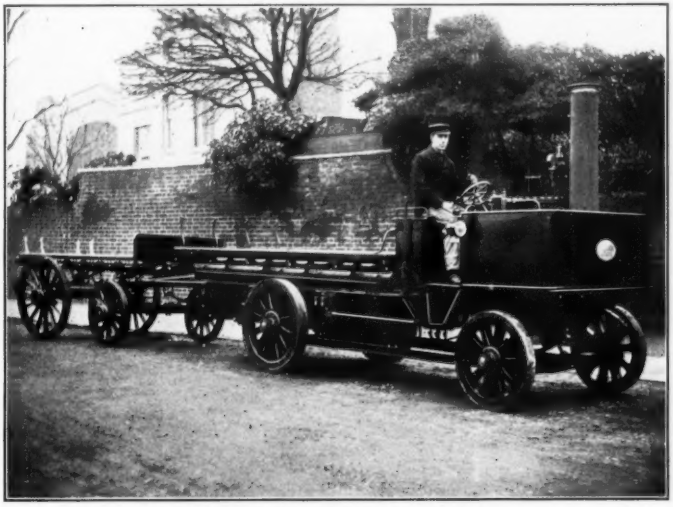
As the essential features of a motor dray are strength, lightness and the concentration of high power in small compass, it is not surprising to find that one of the most successful specimens of the modern light road locomotive is the Thornycroft steam waggon, designed by that eminent engineer, Mr. John Isaac Thornycroft, F. R. S., M. I. C. E., M. I. N. A. His many years' practical experience in such high class

engineering as torpedo-boat construction naturally enabled him thoroughly to grasp and overcome the peculiar problems of road locomotion.

A detailed description of the Thornycroft steam waggon may therefore prove of special interest.

This vehicle is 17 feet 6 inches long by 6 feet 6 inches extreme width across platform. The wheel-base is 9 feet 11 inches longitudinally and 5 feet 6½ inches (center to center of tyres) transversely. The platform is 12 feet ½ inch long by 5 feet 7½ inches wide, and has 68 square feet of available surface for carrying goods. The height of the platform is 3 feet 11 inches when light and 3 feet 9½ inches when loaded with 3 tons; the frame is of channel steel throughout, and is supported upon the axles by ordinary laminated bearing springs; attached to the under side of the rear springs are axle-boxes somewhat of locomotive type, in which the driving axle turns.

This driving axle, which is made from heavy-section forged-steel shafting, affords a good example of the great strength of the vital parts of the mechanism; although required to transmit only 35 horse power as a maximum, it is the same size as a shaft transmitting some 120 horse power at 120 revolutions per minute, this heavy construction being necessary to withstand the reversal of stresses accentuated by

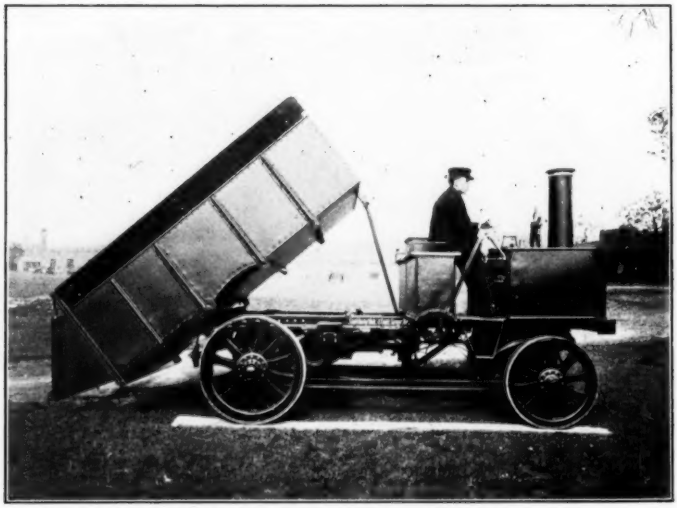


THORNYCROFT LURRY, WITH TRAILER.
Thornycroft Steam-Waggon Works, Basingstoke.

the shocks and jars when running on ordinary roads, to ensure immunity from break downs, and strength to withstand prolonged wear and tear—in short, this vehicle to carry heavy loads resembles in many of its scantlings those of a traction engine.

The wheels, which are of the military type, with metal naves, are stoutly built with oak spokes, ash felloes, and broad and thick steel tyres. The front steering wheels are 2 feet 10 inches in diameter, with tyres 4⅜ inches wide, and are pivoted on Ackermann's system, controlled by worm gearing and a hand-wheel; this steering gear, while having all strains self contained, allows free play to the fore bearing springs; the driving wheels are 3 feet 3 inches in diameter, with tyres 5¾ inches wide.

The boiler, which is placed in front of the driver, is of water-tube type, of annular design, centrally fired from the top and having the fire completely surrounded by tubes which connect the upper (steam and water) annulus with the bottom vessel, the fire being carried in the hollow of the lower annulus in such manner that the tubes are preserved from contact with the ignited fuel. Baffle plates extending about one-third the circumference of the boiler are used to prevent the direct escape of the fire gases, the flame having to find its way on all sides through the narrow spaces left between the water tubes. The fire is regulated by a vertical damper in the ashpan, and the lid covering



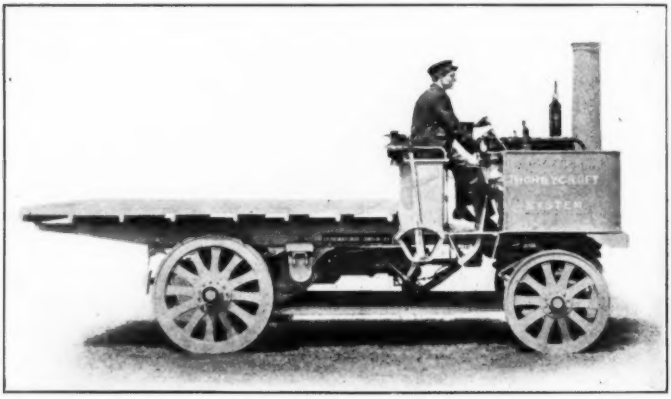
THORNYCROFT VAN TIPPED FOR UNLOADING.

STEAM DELIVERY VAN AND TRAILER.
Steam Carriage & Waggon Co., Ld., Basingstoke.

the central stoking opening in the upper annulus. The necessary draught is created by the exhaust blast. Ample clinkering and cleaning arrangements are provided. Very light top and bottom covers with special steam joints permit of easy and rapid internal examination of the boiler. The tubes are readily cleaned inside and out, and when necessary the boiler can be re-tubed in position. The heating surface is 83 square feet, the grate area 2.4 square feet; the working pressure is 115 pounds per square inch, and the test pressure 350 pounds per square inch. The fuel recommended is steam coal or coke, but provision is made for the substitution of a liquid-fuel burner. Two safety valves are fitted, of which one, set at 5 pounds above working pressure, discharges invisibly and silently from the funnel; the other, rising to a pressure 10 pounds higher, blows directly into the air in full view of the driver, and thus at once draws his attention to the excess of pressure should the first fail to act. The main feed is by a pump, driven direct from the engine shaft by worm gearing, and any excess of water is returned to the feed tank by hand regulation. The suction and delivery valves of the pump are instantly accessible. The auxiliary feed is by a self-starting injector, so designed as to permit of cones being withdrawn and examined while boiler is under steam. All mountings are of the highest

class, a matter of the greatest importance where, as in this case, absolute steam-tightness is so essential.

The engine, which is suspended from the channel-steel underframe from three points, in such manner as to be relieved from strains due to any "winding" or distortion undergone by the frame, is horizontal, compound, reversing, with cylinders 4 inches and 7 inches diameter by 5 inch stroke; it is entirely enclosed in a dust-proof and oil-tight casing containing oil, allowing of the "splash about" method of lubrication, as employed in the Willans, Westinghouse, and other quick-revolution engines; the cost of oil used is but a few shillings a month; access is easily gained to every part. Ample bearing surfaces are provided to ensure durability in continuous running, so that adjustments are needed only at intervals of four to six months. A constant-lead radial valve gear is fitted, having balanced valves below the cylinders, thus giving effective drainage and permitting of any degree of "linking up" or reversing, enabling the power to be varied within wide limits, from 5 to 15 indicated horse power, with very great economy. At 440 revolutions per minute, 20 brake horse power are developed; with the low-speed gear in use it runs up to 770

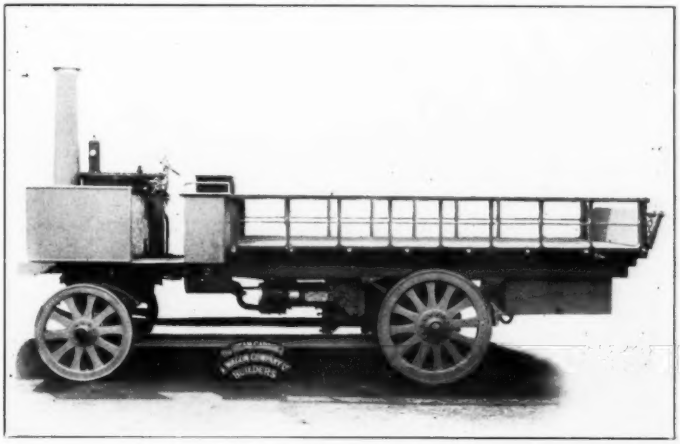


THORNYCROFT STEAM LURRY, 3½ TONS.

revolutions per minute, giving an effective brake horse power of 35. For its power this motor is very light, weighing under 5 hundredweight and measuring only 3¼ by 2½ by 1½ feet. The engine can be disconnected from the counter-shaft and, running freely, without propelling the vehicle, may be employed in driving agricultural, pumping, sawing, hoisting and other light machinery if so required.

A condenser is dispensed with, the exhaust steam passing through a simple form of feed heater (which acts also as a silencer), before reaching the blast nozzle at base of funnel, where it is super-heated and passes away as an invisible vapour under all conditions of atmosphere.

The transmission is chainless. Two pinions are loose upon the engine shaft, either of which engages with and locks into one of two



THORNYCROFT "LONG FRAME" WAGGON.

machine-cut tooth-wheels upon one section of the counter-shaft. The counter-shaft is in three distinct pieces; the first of these is attached to the channel-steel under frame and is driven by the engine; the third is borne in bearings carried by a bracket supported upon the perch-frame and carries a pinion gearing with the double helical spurring on the differential-gear case upon the driving axle. These first and third pieces are connected by a pair of specially-designed universal joints, which permit also of a transverse sliding taking place; these joints, being entirely enclosed, are dust-proof and oil-retaining, and are provided with large rubbing surfaces, thus ensuring durability.

Between the extremes of no load and a "bump," with full load, there is a spring motion of 6 or 7 inches, and this is taken up perfectly by the device described, without interference with the continuous torque exerted on the road wheels, and without in any way straining the vehicle.

The differential gear is carried on the rear axle, which turns in this vehicle; the rear wheels are driven by flat springs attached to the

main axle on the "off" side, and to the sleeve of the differential gear at the "near" side, these pressing against suitable projections from the felloes. In this way the driving wheel spokes are placed in much the same condition of service as in horse-drawn vehicles, and a yielding connection is obtained between the driving axle and road wheels.

The ratios of gearing between the engine and the driving axle are 10.1 and 17.7 to 1. Although on good roads gradients of 1 to 12 can be mounted with the normal or high-speed gear, on occasions when a greatly increased driving effort is required the slow speed gear is used, the vehicle having carried a load of 3½ tons up a

A MILLER'S DRAY.
By T. Coulthard & Co.

gradient 1 to 6 without difficulty by its aid. On all ordinary gradients 5 or 6 tons can be taken, 3 or 4 tons being carried by the vehicle itself and the remainder on a trailing lurry.

Powerful brakes are fitted, acting on the tyres of the driving wheels by means of a pedal in front of the driver, while the reversing of the engine provides a second brake for emergencies.

Two water tanks, the capacity of which is 160 gallons (ample for a run of 15-20 miles), are carried; one forms the driver's seat and the other is attached behind the driving axle. The fuel bunkers, having a capacity of 5¾ hundredweight of coal (sufficient for a full-load run of 40-50 miles), are placed in front and at the sides of the boiler, thus protecting it in the event of collision.

The vehicle is entirely controlled by the driver from his seat on the "off" side, which he has no need to leave, all the starting, reversing,

steering, brake, and feed levers being immediately to his hand, while the pressure and water gauges are in front of him, without obstructing his view ahead.

The following list includes all other recent makes of English heavy motor waggons; the illustrations serve to supplement the description in the text and to give an adequate idea of the general construction and appearance of these waggons.

1. The "Coulthard," made by T. Coulthard & Co., Ld., Preston, Lancashire:

Description.—Carries 2 tons, generator and motor in cab; steering, Ackermann's; platform, 10 feet 5 inches by 5 feet 5 inches, giving 56 square feet loading area; boiler, "Leyland" fire-tube; working press-

BREWER'S DRAY.
By T. Coulthard & Co., Preston.

ure, 225 pounds; fuel, kerosene; engine, triple-expansion, uni-direction, vertical; cylinders, 2¾ inch, 4⅛ inch, and 6 inch diameter by 5 inch stroke; develops 14 brake horse power at 500 revolutions per minute; lubrication, graphite; condenser is carried in front of cab and consists of vertical tier of Row indented tubes; transmission, spur gearing to intermediate shaft, actuated by clutches; final drive by Renold's "silent" chains and chain wheels attached to rear drivers; ratios of gearing, 7, 11½, and 19½ to 1 forward, and 27.4 to 1 reverse; wheels, entirely of iron; brakes, band-brake on second-motion shaft, shoe-brakes on driving wheels, and reverse; capacity of water tanks, 84 gallons; of oil tank, 22 gallons.

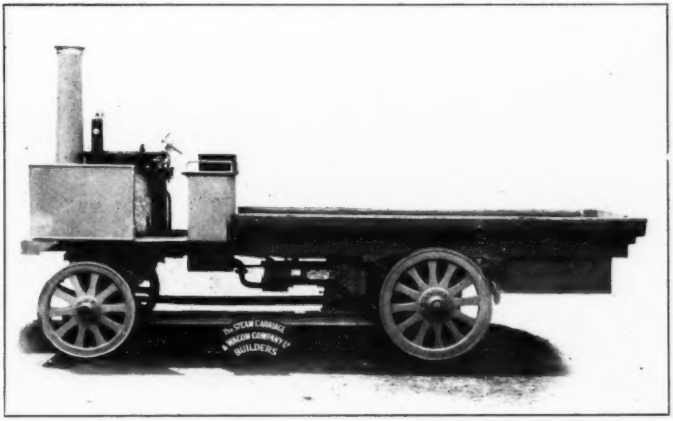
2. The "Leyland"; makers, The Lancashire Steam Motor Co., Leyland, Lancashire:

Description.—Carries 4 tons; generator and motor in cab; steering, Ackermann's, with usual connections; platform, 12 feet 6 inches by 5 feet 8 inches, giving 71 square feet loading area; boiler, "Leyland" vertical, fire-tube; working pressure, 200 pounds; fuel, kerosene; burner, "Leyland"; engine, compound, vertical, enclosed; develops 14 brake horse power at 400 revolutions per minute; lubrication, automatic; condenser, "Row" tube, on top of cab; transmission, by chain to second-motion shaft, and again from it to the road wheels; ratios of gearing give three speeds, 1½, 3, and 5 miles per hour; wheels, of military type, with metal hubs; brakes, both band and shoe brakes are provided; capacity of water tanks, 40 gallons; of oil tank, 15 gallons.

3. "The Mann"; makers, Messrs. Mann, Leeds:

Description.—This, like all the following machines, departs, to a certain extent, from the general lines of preceding vehicles, being a combined tractor and trailer. To all intents and purposes it is a small traction engine, with a lurry platform carried partly on the rear water tank and partly on two wheels, which run loose side by side of the driving wheels upon the rear axle; by means of two pieces, these rolling or loose lurry wheels can be connected to the drivers, thereby greatly increasing the adhesive power and giving a total tyre width of 11 inches. The platform measures 12 feet by 6 feet 4 inches, and carries 4 tons; steering, by means of worm and quadrant; boiler, loco-

STEAM LURRY.
By T. Coulthard & Co.



THORNYCROFT LONG FRAME LURRY.

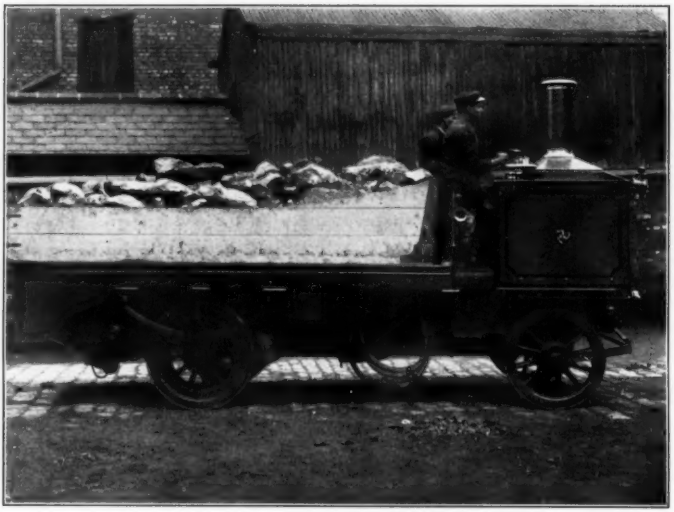
motive type, 24 tubes, 1¾ inch diameter; total heating surface, 53 square feet; fuel, coke; working pressure, 150 pounds per square inch; engine, horizontal compound; cylinders, 4 inch and 6½ inch diameter by 8 inch stroke, with single eccentric reversing gear; develops 14 brake horse power at 250 revolutions per minute; transmission, by cast-steel gearing and differential gear; speeds 2½ and 5 miles an hour; wheels, entirely of steel, tyres made separate, allowing of renewal when necessary. Brakes, one on main driving wheel, one on the lurry wheels and reversing of engine. Capacity of water tanks, 108 gallons.

The "Bayley"; builders, Bayley, Ld., Newington Causeway, London, S. E.:

Description.—Carries 3 tons; generator in front; motor in casing forming driver's seat; steering, Ackermann's, controlled by hand wheel and spur gearing; platform, 9 feet 9½ inches by 6 feet 2½ inches; area, 61 square feet; boiler, modified de Dion et Bouton type; fuel, coke; engine, vertical compound, inverted; cylinders, 4 inch and 7 inch diameter by 5 inch stroke; stated to develop 22 brake horse power at 500 revolutions per minute; is completely enclosed in oil-tight and dust-proof casing; transmission, bevel and spur gearing are used to transmit the power. The after-end of the crank-shaft is prolonged and carries two spur wheels, which drive a lower longitudinal shaft, each gear being put into engagement by a sliding clutch. This lower shaft is coupled by a universal joint to the main longitudinal transmission shaft, which is geared through bevel wheels to the compensat-

ing motion upon the transverse shafts, which in turn drive the rear road wheels by pinions engaging internal spur-rings. All the transmission gears and shafts are encased in cast-iron grease boxes. Ratios of gearing, 8.4 and 13.7 to 1. The wheels, which are dished, are of the military type. Brakes, double-purchase wood-block brake on the crank-shaft, actuated by foot-pedal, band-brakes on pulleys, outside spur-ring on driving wheels, worked by hand lever; these in addition to reversing the engine. Capacity of water tanks, 82 gallons; of bunkers, 3 hundredweight of coke.

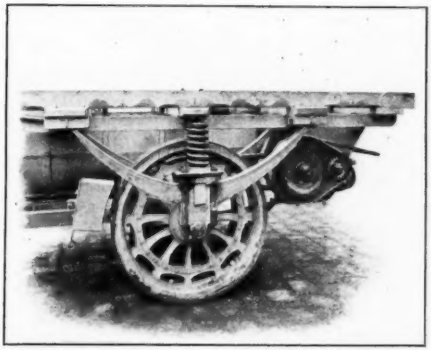
"Clarkson Capel"; makers, Clarkson & Capel Steam-Car Syndicate, Ld., London.



STEAM LURRY WITH COAL BODY FOR 4½ TONS.

Length over all, 16 ft. 6 in.; length of platform, 11 ft. 6 in.; width, 6 ft. 5 in.; height from ground, 3 ft. 8 in.; water capacity, 140 gals. = 20 miles; fuel bunkers, 6 cwt. = 40 to 50 miles; fuel used, Welsh coal or coke. By Simpson & Bodman, Manchester.

Description.—Carries 3 tons; generator and motor in cab; steering, Ackermann's, controlled by hand wheel and worm gearing, with roller bearings fitted to the short axles; platform, 11 feet by 6 feet 4 inches; area for goods, 70 square feet; boiler, fire-engine type, with small inclined steel cross-tubes (water tubes); working pressure, 200 pounds per square inch; test pressure, 350 pounds per square inch; fed by pump driven from engine; feed controlled by automatic reciprocating float-gear; fuel, petroleum; burner, "Clarkson Capel," which is of the



REAR END OF SIMPSON & BODMAN LURRY.

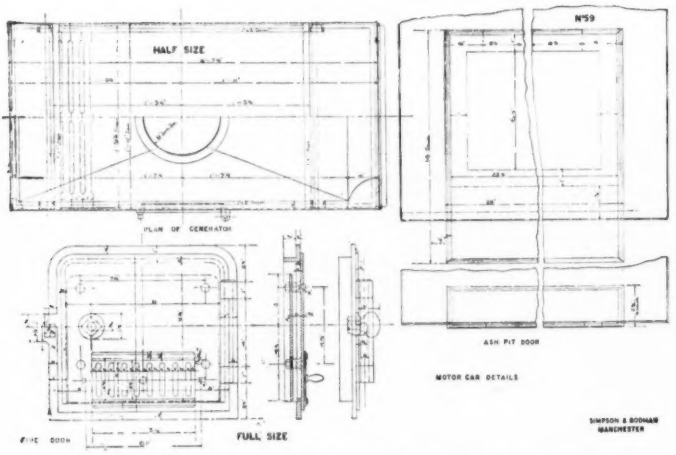
true Bunsen type; engine, vertical, compound, reversing; cylinders, 2¾ and 6 inch diameter by 4 inch stroke, enclosed in oil-tight casing; stated to develop 14 brake horse power at 600 revolutions per minute; piston valves used in both cylinders; cylinders not lubricated; atmospheric condenser is fitted on roof of cab; propelling fan used for cooling purposes; transmission, the engine shaft carries a two-speed gear of novel construction, of which the higher is put into engagement by an expanding clutch; final drive from compensating gear to road wheels by Renold's chain; ratio of gearing, 12 and 36 to 1; brakes, band-brake on engine shaft, steam brake on driving tyres; wheels have phosphor-bronze hubs, being of the artillery type, with reservoirs for lubrication; capacity of water tank, 49 gallons, and of oil-tank, 30 gallons.

"Simpson & Bodman"; makers, Simpson & Bodman, Cornbrook, Manchester:

Description.—Carries 5 tons; generator in front; steering, the steering arms outside of wheels, instead of inside as usual; platform, 17 feet 4 inches by 6 feet 5½ inches; area for goods, 98 square feet; generator, flash type, built up of Row's tubes, connected by return bends and Haythorne's joints; fuel, coke; working pressure, 100 pounds

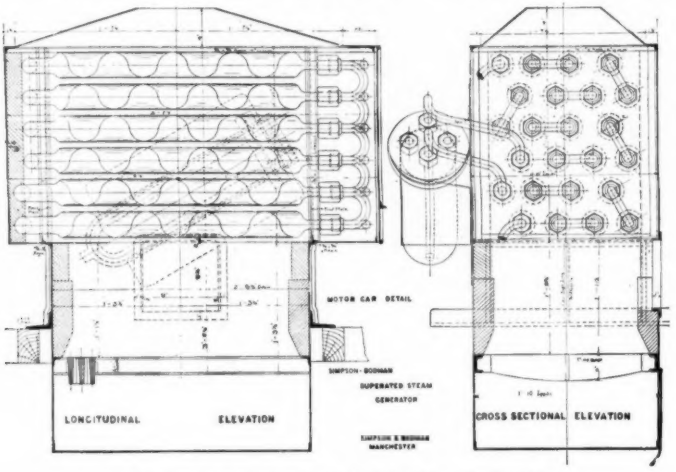
DAMAGED BOILER TUBES, AFTERWARDS STRAIGHTENED AND REPLACED AT SMALL COST, AND NOW AT WORK.

The lurry, of Simpson & Bodman's make, jibbed badly at the foot of a steep hill during a snowstorm. For 5 hours the fire was kept up vigorously, and through inattention these tubes sagged down as shown. They are, however, practically uninjured, weighing now 176½ lbs. as against 180½ lbs. when new.

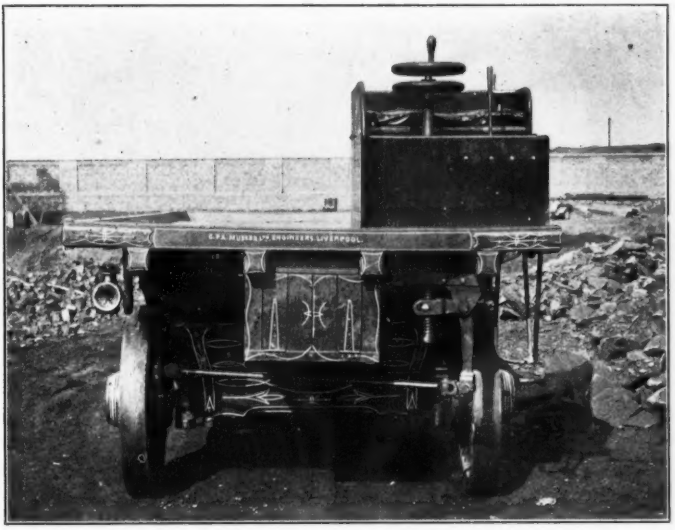


PLAN OF GENERATOR AND DETAILS, SIMPSON & BODMAN MOTOR WAGGON.

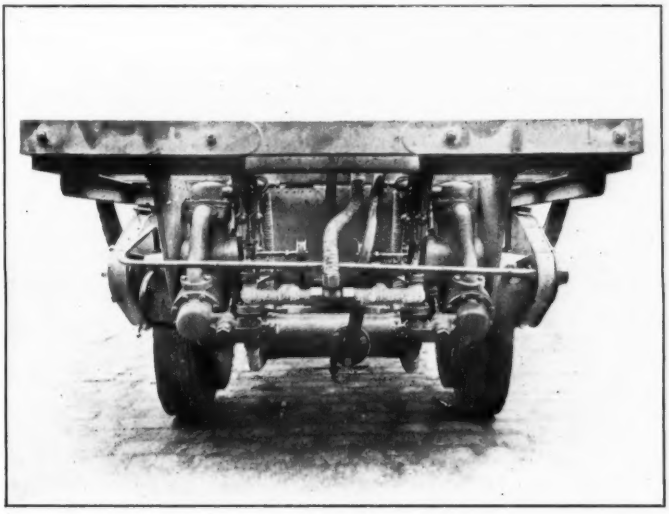
per square inch; engines, three-cylinder single-acting, one on each side at rear of vehicle, with simple reversing gear; transmission, from each engine to each driving wheel by means of spur gearing and chains; wheels, exceptionally strong, of wood and metal; brakes, one "toggle" tyre brake and reverse of engine; capacity of water tank, 100 gallons; of coal bunkers, 6 hundredweight; differential or compensat-



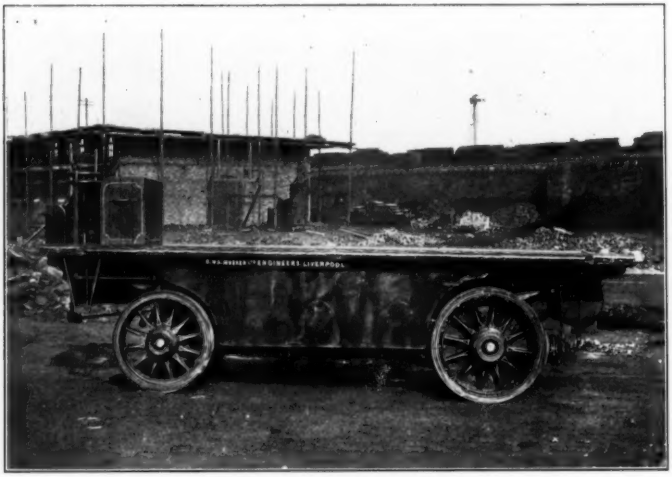
SIMPSON & BODMAN STEAM GENERATOR. ELEVATION.



10-TON STEAM WAGGON. FRONT VIEW.
C. & A. Musker, Liverpool.



BACK VIEW OF SIMPSON & BODMAN LURRY.



SIDE VIEW OF 10-TON STEAM MOTOR WAGGON.
By C. & A. Musker, Liverpool.

ing gear is not employed. This is the simplest and most commercially-practical vehicle employing a flash-type boiler.

The "Musker"; makers, Messrs. Musker, Liverpool, being as yet only in its experimental stage, no reliable data of this vehicle are at present obtainable. Its special features are, however, an efficient liquid-fuel burner, combined with a flash-type boiler built up of three cylindrical coils of strong steel tubes, the flame being made to circulate in the annular space between them. The waste products of combustion require no chimney for their escape; the burner and boiler are fed automatically by a separate engine, which also drives a fan for the supply of necessary blast to burner. It is claimed that this motor vehicle is absolutely automatic in its action. The generator and all mechanism being below the platform, a much larger loading area is secured than on any other vehicle.

COMMERCIAL REQUIREMENTS OF WATER-POWER GOVERNING.

By Elmer F. Cassel.

WATER power always has been, and probably always will be, the one great and inexhaustible source of power for the use of mankind. To all intents and purposes water power is perpetual motion. Its continuous use exhausts none of the resources of nature. It is abundant beyond any conceivable demands which may be made upon it. The total amount of power used in the United States alone, water, steam and every other kind, is approximately 4,000,000 horse power. The total available water power of the rivers and streams of the United States has been estimated at 200,000,000 horse power. Italy, without any coal supply, has 5,000,000 horse power of water available. Canada's water powers rival those of the United States, Norway and Sweden can furnish over 50,000,000 horse power, Switzerland, Austria, Germany, France, India, Japan, Australia—all contain almost unlimited supplies of power.

Boundless as is this supply, it is only in recent years that its systematic development has taken place to any great extent. Especially in high-head power is this the case. Notwithstanding the fact that water is the cheapest known source of power, that its use and economy have been known for ages, and that it gives the most compact and convenient installation that can be devised—it was not until modern commercial demands made its more extended use imperative that any improvements in machinery for its utilization have appeared.

With such a source of power, having every apparent economic advantage in its favor, it is evident that its use must be hampered in some way, else it would to-day be much more extensive than it is. *It is a self-evident proposition that the cheapest known source of power will be used in every case if it is feasible to do so.*

The one great (and practically the only), drawback to the use of water power has been the inability to control it. In high-head power this difficulty is exceptionally great. Up to last year the problem of governing high-head water remained unsolved. Some engineers have gone so far in their statements as to say that the problem contained difficulties perhaps impossible to overcome. I am perfectly aware that several governing devices are offered and are in use, in many cases

with considerable success, but the fact remains that the use of high-head water at present is practically confined to plants where the variation in load is slight, where variations in speed are of no consequence, or where the expense of installation is no object.

The absolute reliability of the steam engine under all conditions has made it pre-eminently the great source of power the world over. The purchaser of a steam engine buys a machine that is entirely self-contained and absolutely reliable under all conditions of load. Whenever water-power plants can be put in with absolute certainty as to results, as is now the case with the steam engine, the use of water power will be enormously increased. Thousands of water-power plants are in use to-day, not because they are satisfactory, but because they are economical. The water wheel that is successful under all conditions must be as self-contained as the steam engine and as reliable. When this is accomplished it can be said that the problem of water-power governing has been solved. The field for large water wheels is comparatively limited, while the field for small water wheels is almost unlimited. The small purchaser of water wheels expects his water-power plant to be not only reliable, but comparatively inexpensive. He expects his power plant to take care of itself, for the reason that supervision is one of the items of expense he plans to do away with. He knows nothing of the various theories of governors, and if his water-wheel governor gets out of adjustment there is nothing he can do to make his plant continue running at all except to take out the governor entirely and govern his water wheel by hand.

A study of the modern practice of water-wheel governing discloses the fact that present practice is, in the great majority of cases, an attempt to accomplish the impossible. The first attempts in the line of governing water wheels were, very naturally, suggested by the practice of governing steam engines—that is, by arranging to vary the supply of water delivered to the wheel. Under the low heads in use in earlier times the difficulty of cutting off the water supply sufficiently quickly to perform the act of governing was great, and with the use of modern high heads this difficulty has been very largely increased. The inertia of a column of water moving rapidly through a long pipe line is enormous, and any attempt to shut off this water suddenly will result in the ultimate destruction of the pipe line. This fact has been stated and fully recognized by every engineer who appears of record on the subject, some of them intimating that it is probably a condition that cannot be overcome. Nevertheless the efforts of a large majority of engineers and inventors have been turned in that direction, and

many of them to-day are still working on the attempt to accomplish the impossible. In the cases of large installations, where expense has been no object, some success has been achieved. This has been done by means of stand pipes to which the flow of water is diverted when shut off from the wheel, relief valves being used in addition in some cases. In this form of governing any form of centrifugal governor can be employed, its sole purpose being to throw in or out of action the mechanism necessary to operate the valves.

One idea which seems to have determined the desirability of controlling a water wheel by regulating the supply of water seems to have been that of conserving the water itself. As a common-sense proposition the conclusion must be arrived at that the successfully governed water wheel must be governed entirely independently of the flow of water. It is always good mechanics to avoid that which is difficult to overcome. The flow to a water wheel forms no factor in the problem of successful governing, although it does become an object of consideration in some cases, in the conservation of the water supply. In nine cases out of ten, however, among the small but numerous users of water wheels, it makes no difference whether the water is running out of the nozzle or going to waste over the penstock.

Another class of governor which has attained some degree of success is that class which acknowledges the above proposition and governs the power wheel by diverting the nozzle, or stream, away from the wheel. This may be called the second stage of water-wheel governing. At first thought, it might seem that close regulation by this means would be a simple and inexpensive arrangement. The underlying fault in this class of governors is the same as one of the faults in the first class of governors.

As it was pointed out in discussing the first class, a centrifugal governor is used to put in or out of action the mechanism for operating the gates, relief valves, etc.; so, in the second class of governors, a centrifugal governor is used to throw in or out of action the mechanism to raise or lower the nozzle. Obviously, it is impracticable to arrange a centrifugal governor which would have in itself the inherent power to operate a deflecting nozzle directly. In the steam engine the position of the cut-off valves is controlled by direct connection with the weights of the centrifugal governor used, and as a consequence the revolutions of the engine, while they increase slightly with a decrease in load, are constant and invariable at any given condition of load. With the water wheel, however, under both of the forms of governing cited, the condition is entirely different. An increase in speed in the

centrifugal governor used throws into action the mechanism necessary to close the valve or deflect the nozzle. As a consequence, this mechanism is not thrown out of action until the speed of the centrifugal governor itself is reduced sufficiently. This action requires time, and while the centrifugal governor has acted promptly, the time occupied by it in throwing out of action the mechanism used to move the valve, or deflect the nozzle, has permitted the valve or nozzle to be moved further than was required to reduce to the proper point the power applied to the wheel. The consequence is that by the time the governing action has occurred there is not enough water reaching the wheel to keep it up to speed. This causes the slowing down of the centrifugal governor below normal speed, thereby throwing into action the mechanism for opening the water valve or raising the nozzle. Before this action can be stopped the water wheel is increased in speed beyond its proper limit and the reverse action again takes place. The best that can be said of this class of governors is, that they confine the speed of the water wheel within certain limits, but do not keep the speed constant at any point within those limits.

Various attempts have been made to overcome this fault in both classes of governors. Additional governors have been devised and added, designed to arrest the action of the first governor. Balance wheels of great weight have been added to the water wheel to assist in controlling the speed of the wheel while the governor has time to act. In some cases the weight of the water wheel itself has been enormously increased. Storage batteries and other means of absorbing excess power have been suggested and used. It is not essential to discuss these latter features at all. They dodge the real question of water-wheel governing. The very best thing that can be said of such contrivances is, that they are attempts to govern the governor.

From a study of the above two forms of governing water power, there are two reasonable deductions to be arrived at, namely:

First, A properly governed water wheel must avoid entirely any shock or strain to the pipe line.

Second, A properly constructed governor must have in itself the inherent power necessary to perform the governing action.

In addition to this, there is a third fundamental requirement before a governor can be said to be commercially successful, and that is:

Third, The governor must be absolutely reliable.

There is a fourth consideration of almost as much importance commercially, although of no importance mechanically, and that is:

Fourth, It must be inexpensive.

In order to make the use of water for power as extensive as it should be—in other words, to make its use practicable in all cases where the water power exists—economy of installation and operation and certainty of results are the two prime requisites. If the economy of the use of water for power is offset by the increased cost of installation, maintenance, or operation, it is folly to contend that the problem of governing water has been solved from a commercial standpoint. If by installing water power to save labor needed to oversee machinery and keep it in operation, you still have to keep that labor to oversee and keep in repair your governing devices, the true solution of governing water has not yet been solved. If your governing device is intricate, has any liability to get out of order, requires any attention whatever—it has not solved the problem of high-head governing. I have seen governor after governor taken out and thrown away, not because they could not be made to work fairly satisfactorily, but because there was no one around at the time who could do so. It is in water power, as in everything else; the large installations attract attention, and it is at these installations, where expense for installation and for intelligent labor to keep the plant in adjustment is not considered, that water governing has achieved any success. The universal use of water power depends almost entirely upon the small users, and not upon the large. Where there is one large installation to be put in there are hundreds of smaller installations, where the variation of load is always much greater than in the larger plant, which would be put in could these small plants be governed satisfactorily.

It is upon the deductions drawn from the above lines of reasoning that I have achieved considerable success within the past year. Starting with the proposition that the flow of water in the pipe line must be left alone, and that the governor in itself must contain the inherent power necessary to perform the governing action, there remains but one line of experiment to pursue. In following this out the following facts were developed:

First, An impact wheel can be so arranged that the buckets against which the water strikes can be moved out of the line of impact, such movement requiring a very slight application of power.

Second, In the centrifugal force developed in the rotation of the wheel body itself is found the necessary power to move the buckets out of the line of impact.

The construction which best recommends itself to this principle is the division of the wheel along the center line of the buckets into two sections, so arranged that any increase in the speed, causing an in-

crease in centrifugal force of the moveable parts of the wheel, will cause the two sections of the wheel to separate, allowing the jet of water to pass wholly or in part between the buckets, instead of impinging directly upon them. The simplicity and advantages of this construction are apparent. It obliterates entirely the numerous complications which it has been the study of engineers to overcome. The governing action is in the wheel itself, it is instantaneous, the wheel is entirely self-contained, and the speed of rotation is absolutely constant at any point. The action of the wheel is entirely automatic, nothing being required in its operation except turning on the water when starting up the plant. The wheel contains but four moving parts; there is nothing to wear out nor to adjust after the wheel leaves the factory.

A great feature of this construction is the fact that while it does away entirely with any shock to the pipe line and requires no expense whatever for safety arrangements in governing, still, where the conservation of the supply of water is an object, it permits the use of any of the various devices for slowly shutting off the head of water without danger to the pipe line.

The above radical departure from former practice in water wheel governing would not be complete without the statement that the correctness of the conclusions arrived at has been fully demonstrated by eight months' continuous use. During that time an electric plant run by this wheel has not required a dollar of expenditure for labor to operate either the water wheel or electric plant. The variation in load is often over sixty (60) per cent., instantaneously, and to use an expression of an engineer who examined the plant, "under those conditions the indicator showed less variation than is usual in steam-driven plants where the load is practically constant."

The simplicity and economy of this form of water-power plant leave nothing to be desired. In many cases it makes possible the installation of a water-power plant for the selling of water power direct, without first converting it into electricity. It makes more feasible than ever the use of water power in a field which lately has been receiving the consideration of eminent engineers, namely, that of using water for distributing power by means of a centrally located pumping plant. The cheapness of installation permits its use by even the smallest manufacturer where he has water power to use. The desirability and advantages of the use of water under high pressure for power purposes are becoming more and more recognized every day, and any invention which makes the use of this power universally available may well be classed as one of the great inventions of the age.

APPLICATIONS OF ELECTRICITY IN THE COLLIERIES OF GREAT BRITAIN.

By Sydney F. Walker.

EALING in my preceding paper with the chief underground power applications of electricity in coal mining, I discussed rock cutting, haulage, and pumping. It remains to consider the collateral uses for lighting and signalling, the surface plant (which is less specialised in its character), and the peculiar problems attending underground transmission and distribution.

Lighting by Electricity.—Arc lights are not much employed at collieries, nor have they been since the advent of the large incandescent lamp. Those which are used are now generally of the enclosed form, in which the carbons burn in an atmosphere very largely composed of carbonic oxide gas and so do not consume so quickly as the ordinary form, the lamps only requiring to be trimmed every 100 hours or so of actual burning. The great objection to the ordinary arc lamp is the attendance required for trimming with fresh carbons daily and sometimes oftener, and also the fact that the coal dust which is so much in evidence about every colliery seriously interferes with the working of the mechanism of the lamp. This is especially felt where, as sometimes happens, the lamp is used only occasionally, and is then required quickly. Principally, then, incandescent lamps are used, varying in power from 8 candle power up to 500 candle power.

For the pit banks, sidings, yards, etc., it is usual to employ lamps of 100 candle power to 500 candle power, arranged in a fitting similar to that now often used for lighting side streets or courts in towns, consisting of a strong enamelled-iron shade, forming at once a protector and a reflector, with a well glass below, outside the ordinary lamp glass. The whole thing—shade, well glass, and lamp—is usually attached to brackets or to tubes that can be fixed on top of poles, or in any convenient position.

The smaller lamps are arranged and protected in various ways. For the inside of engine houses, offices, etc., the well-known pendant lamp with conical shade of enamelled iron or opal is used. For other

Mr. Walker's first article on this topic appeared in THE ENGINEERING MAGAZINE for August, 1900.

places, as at pit bottoms, on main roads, other forms in which the lamp is protected are employed. The bulkhead lamp fitting used on board ship, consisting of a ring with metal back and stout concavo-convex glass, the lamp being held between them, is very useful, as it can be sunk in the brick work well out of harm's way, yet so as to obtain the full benefit of the light. Another fitting that is much used on board ship, consisting of a short, stout, metal bracket supporting a water-tight wire-guarded fitting, is also of service where space allows.

The current for the electric lamps throughout the mine is sometimes taken from the power service, in which case they are arranged in groups of three or five, according to the pressure, each group, or a number of groups, being arranged to switch in or out together. Where a 220-volt service is employed for both light and power, as at Ackton Hall colliery, lamps can be controlled individually.

The plan described, of arranging several lamps in series, has the disadvantage that it leads to waste of lamps, and also that if one of the group fails, none of the others can be used. It has the great advantage, though, that it entails fewer joints.

More frequently, however, if the lighting service is of any magnitude, it is supplied by a separate dynamo, except in the case of those lamps in pumping or coal-cutting stations which may be at some distance from the pit bottom, and so would entail a heavy additional expenditure for cable.

In my opinion, the better plan is, where possible in mining work, to keep the lighting service separate from the power service. It may often happen that light is wanted when it is required to stop the power service; and in addition the power service is necessarily subject to continual variation, leading to continual fluctuations of pressure, and the consequent winking of the light is most painful to the eyes.

There is one other method of lighting coal mines by electricity, *viz.*, by means of portable lamps. In the early days of coal mining, the only light available was that of the candle, and this is the case in Cornish mines at present. Old colliers will tell you that they can always detect the presence of gas more quickly in their working places with a candle than with the ordinary safety lamp, and that they can always clear it off in a few minutes by fanning with their coats, the candle standing on the ground meanwhile, out of harm's way, the gas collecting near the roof. But mines are very different now from what they were in the typical old collier's day. Explosions in those days, when they did take place, were only local, and did little harm, beyond burning the clothes and skin of those near. In these days, an explo-

sion often means the loss of hundreds of lives, and the wrecking of the mine, so that though many collieries are still worked by naked lights, either candles or small oil lamps, the number is becoming less every year, the pressure of the mines inspectors being constantly directed to the adoption of safety lamps.

In most collieries then, the work at the face of the coal and beyond certain points in the mine is done by the aid of safety lamps. But the ordinary oil-burning safety lamp gives but a poor light, and it must not be used in any position much out of the vertical, or it goes out; and moreover, it is not a perfect safety lamp in the proper sense of the term, inasmuch as any one of the numerous forms will become red hot and explode, if it is exposed to a sufficiently powerful current of an explosive gaseous mixture for a sufficient time. Hence great efforts have been made to develop a portable electric lamp which shall take the place of the present safety lamp, at the face of the coal and in those parts of the mine where it is not considered safe to use lamps from the ordinary electric service.

Not much progress has yet been made in the matter in Great Britain, partly on account of the difficulty of the problem, partly on account of the difficulty that always attends the introduction of a new thing involving radical changes, and partly because some mining engineers will not admit the utility of a lamp, however safe it may be, which does not denote the presence of gas, as the old lamp and even candles do. The light for the face, they say, fulfills two offices —giving light and warning the miner of the presence of gas. On the continent, however, comparatively heavy electric safety lamps are in use. Notwithstanding this, I have every confidence that the next few years will see great developments in this direction. The portable electric lamp consists of a case, in which is stored sufficient electrochemical energy to furnish current for a one candle-power lamp for 10 to 12 hours or more, with a small incandescent lamp attached, the lamp being either on the top, the side, or the bottom of the case, the lamp itself being protected by a stout outer glass, similar to that used with the ordinary oil safety lamp, and usually, also, if above the case, with a metal plate and with wire guard rods.

A hook or ring for carrying the lamp completes the equipment, but in some forms of lamp there is also a switch to turn the current off when not required. The case containing the cells which form the supply of energy is also protected with an outer case, either of steel, aluminum, or wood.

The supply of energy is contained in galvanic cells, in the existing

patterns in use in Great Britain now always limited to two, though on the continent more than two are used, which may be of the primary or secondary form. In the primary form a liquid is poured into the cell, zinc rods are placed in the position allotted them, the cover is screwed on, and the lamp is alight. After the run, the old liquor is thrown out, the remains of the zinc rods are replaced by new ones and fresh liquor is put in.

With the secondary form of battery, the lamp when received from the miner is placed on a charging table with other lamps, and charged by a current of electricity, either from the ordinary lighting service, or from a dynamo specially arranged for the work.

SUSSMAN'S ELECTRIC MINER'S LAMP, WITH SECONDARY BATTERY.

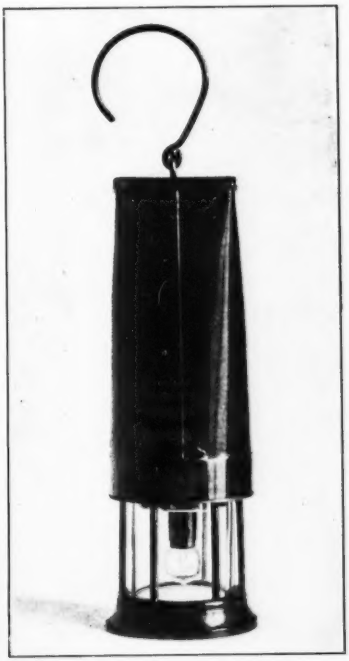
The present practice is to use the ordinary lighting service, and the lamps therefore are charged in groups, just as the lamps taken from the power service are, a small tell-tale incandescent lamp being connected in series with each group to show that current is passing through, and an adjustable resistance provided so that a smaller number may be charged in any group if desired. Both primary and secondary lamps require to have their glasses cleaned after being in use in the mine, before being reissued, but this is by no means such a long operation or so troublesome as cleaning the gauzes, glasses, etc., of the old form.

There have been many forms of secondary battery lamps brought out, but so far as I am aware only two are now before the public, *viz.*, the Sussman and the Headland. One large colliery, South Hetton, in the County of Durham, has one thousand Sussman lamps in use, in charge of their own men.

In the Headland lamp a very ingenious switching arrangement is provided. By turning the base of the apparatus in which the glow lamp itself is held, through an angle of 90°, the current is turned on or off.

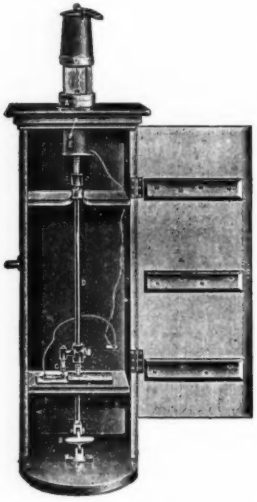
Many attempts also have been made to introduce a primary-battery lamp. So far as I am aware, the only one surviving, which has, however, not yet been placed on the market, though it has been tested in several collieries, is that shown on page 851, worked out by myself.

Lighting Locked Safety Oil Lamps and Locking and Unlocking Them by Electricity.—Electricity is used also for lighting the old form of lamp, and also for locking and unlocking them. One great danger of coal mining, where explosive gases are given off by the workings, is the willful carelessness often displayed by the miners in opening their lamps. A miner's lamp goes out, possibly owing to his having tipped it too much out of the vertical. The lamp station, where a light is kept and where he can have his lamp relighted, is some distance away, perhaps a mile. To relight his lamp, he must take his "butty's" lamp with him to see the way, so that both have to stop working for a time. The temptation is great to open the "butty's" lamp, if possible. Or, a man badly wants a smoke; he has tobacco and a pipe, and again he is strongly tempted to unlock his lamp. To prevent this, and also to save time in lighting lamps in the morning when many hundreds of men are going down the mine, a method of lighting by means either of a heated wire or of a small spark has been



HEADLAND'S ELECTRIC MINER'S LAMP.
Worked by a secondary battery held within the iron case which forms the upper portion of the lamp.

WALKER'S ELECTRIC MINER'S LAMP
This lamp is worked by a primary single-fluid battery.



ELECTRO-MAGNETIC APPARATUS FOR UNLOCKING LOCKED SAFETY LAMPS.

devised. It consists usually of a small platform with a circular hollow, into which the bottom of the lamp fits. In the hollow are two electric-contact pieces connected with a source of electricity, and on the bottom of the lamp are two other contacts which engage with those on the table, and which are in connection with the lighting apparatus over the wick. On placing a lamp in the stand, a current passes and the lamp is quickly lighted.

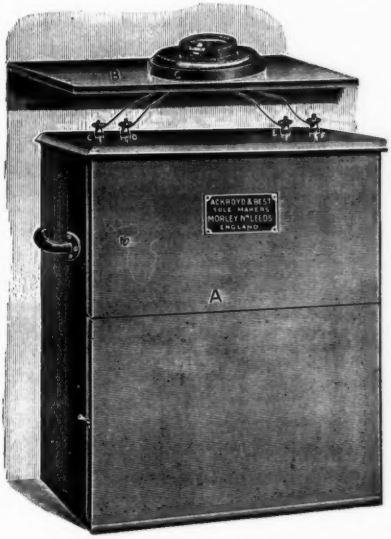
In connection with this also, in several forms of safety lamps, a magnetic lock is provided, consisting of an iron plunger forced into a recess by a strong spring, locking the two parts of the lamp together. On placing the lamp over a powerful electromagnet, the iron plunger is pulled down against the opposing force of the spring, and the lamp is unlocked, and can only be unlocked by the magnet. With all these elaborations, however, the simplicity and safety of the electric lamp is not approached.

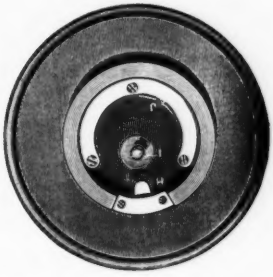
Working the Surface Plant and Auxiliaries by Electricity.—Once an electric-power plant is installed, whether at a colliery or at any works, it is surprising how many appliances it is found convenient to work by its aid. It is only running out a pair of cables, fixing a motor, and taking a belt or rope from its pulley. Thus at Ackton Hall colliery, Pontefract, coaling screens, coal washers, traveling belts, tip hoists, pumps in out-of-the-way positions, etc., are worked from the electric-power service.

Signalling and Speaking by Electricity.—Perhaps the most useful electrical apparatus about any mine is the signalling arrangement. For haulage roads, whether the work be done by main-and-tail rope travelling from 8 to 10 miles an hour, or by endless rope at only 2 miles, more or less serious accidents are constantly taking place that would lead to serious damage, and possibly to prolonged stoppage of the mine, if the rope were not quickly stopped. The old mechanical signal, consisting of a galvanised-iron rope pulling a bell in the engine house, takes time and considerable force to operate. So a very simple system of electric signalling has been arranged for the purpose. A

powerful electric bell is fixed in the engine house, near the engine man, and a battery of Le Clanché, or bichromate, cells is fixed in any convenient position near. Two naked iron wires are fixed on small insulators attached to props on the side of the engine road, the wires being only a few inches apart throughout the road but never touching. The iron wires are connected with the bell and battery, so that by pressing them together at any point, or by placing any good conductor across them, the circuit through bell and battery is completed and the bell rings. In case of an accident, the rider with the journey of trams or the attendant hooking or unhooking a tram from the endless rope has only to grasp the two wires, as he can easily do, and the engine man knows and can stop.

For long engine planes on which the endless-rope haulage system is employed, the above arrangement of signals is often extended by placing a bell, similar to that in the engine house but smaller, at each of the junctions with the secondary haulage roads and making all the bells ring simultaneously, including that in the engine house, when the two naked iron wires are pressed together. This arrangement enables help to be called to any particular junction, when required, by preconcerted signal.





ELECTRIC APPARATUS FOR LIGHTING LOCKED SAFETY LAMPS.

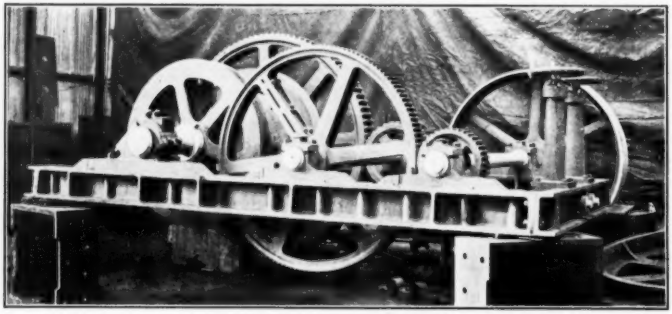
It is also the practice in some mines, not those where the haulage plant is worked by electric motors, to place the hauling engine on the surface, the power being transmitted to the mine either by an endless band rope working the haulage drums near the pit bottom, or by

making the whole rope travel from the engine on the bank to the end of the road.

In either of these cases, the signal may be made to ring simultaneously at the pit bottom, at the haulage drums, and in the engine house on the surface.

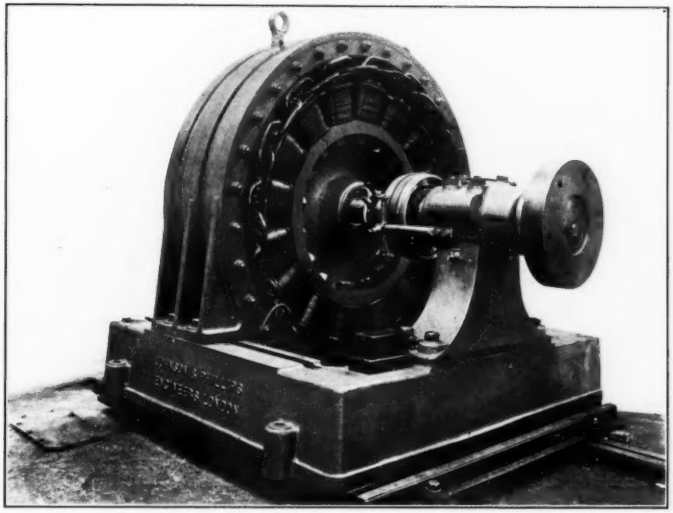
An extension of the signalling arrangements described above is the use of the same signalling wires for speaking to the engine driver from any part of the engine road. When this arrangement is made, a microphone transmitter is fixed in the engine house, with a switch enabling the engine driver to reduce the strength of the battery from that required for the signals to that required for the microphone, and at the same time to cut the bell out of circuit. The riders who go with the journeys of coal and the attendants at the junctions, as well as the overmen and others, carry in their pockets one or two small telephone receivers of the watch pattern, having clips on the ends of their connecting wires.

When anyone wishes to communicate with the engine driver, he rings a pre-arranged number of times on the signal bell, and then hooks his telephone on the wires, places it to his ear, and waits. He can hear the engine man make the necessary connections and can then speak with him. By having two receivers, one can be at the ear and the other at the mouth. In the quiet of the mine speech is remarkably



ENDLESS-ROPE HAULAGE GEAR, WITH TWO ROPE PULLEYS, READY TO BE FIXED UNDERGROUND.
Made by Ernest Scott & Mountain.

clear and distinct with this arrangement. In some mines a number of telephone stations are arranged in various parts of the mine, to and from which communication can be made. Electric signals are also used for the cage in the shaft, bells being fixed at the pit bottom, the pit top, and in the engine house; and contact makers, enclosed inside



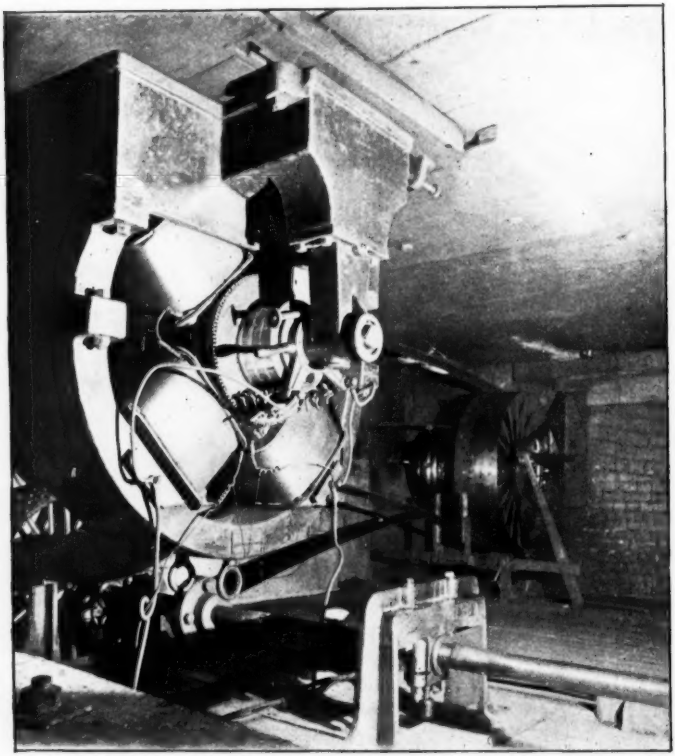
TWO-PHASE ALTERNATOR, FOR MINING POWER PLANT.

The machine shown above was built for Burmah ruby mines by Johnson & Phillips.

iron boxes, at the pit top and bottom. They are very much quicker than the old mechanical signal, but they have not found so much favour as the haulage signal, as they require more attention. There is usually a good deal of water at a coal-pit bottom, which will find its way, in spite of the most elaborate precautions, to the working contacts, and destroy the connection unless frequently examined.

Where electric shaft signals are used, the same wires are often made use of for a telephone service between the surface and one of the cabins underground, ordinary telephone apparatus being employed and brought into connection by their own switches on receipt of prearranged signals.

The Generating Plant.—As with most new developments, the use of electricity for lighting, power distribution, etc., at collieries, has grown up by degrees. The very early plant consisted of a single dynamo, sometimes driven by its own engine, sometimes by the fan or workshop engine, and placed in the fan-engine house or in the workshops at the colliery, and this was often supplemented by other isolated dynamos placed near the pit bottoms for underground work. Further, where two or more collieries were under the same ownership, separate plants were placed at each colliery, and often more than one at each.



MOTOR SUSPENDED UNDER BEAMS OF COLLIERY PIT HEAP, DRIVING SHAFTING OF COAL-WASHERY PLANT, ACKTON HALL COLLIERY.

All that is changed now. The latest practice involves one generating station, at any convenient place at the surface, as near the boilers as possible. In this are placed two or more generators, capable of dealing with all the work, lighting, and power, at the colliery. The dynamos are, in the United Kingdom, usually of continuous-current type, but on the continent of Europe and in the colonies alternating-current plant, principally polyphase, has been employed, and this last is also in use at Garswood Hall colliery, near Wigan.

The continuous-current plants are very diverse. In some collieries only one service, that for power, at 500 volts, is provided, the lighting service being taken off the power cables. In other cases, a separate plant is provided for the power service at 500 volts, and another serv-

ice at 100 volts for the lighting, each plant having its own engines driving its own dynamos. Again, another arrangement is to have the whole service at 200 or 220 volts, both lighting and power, but to have two or more dynamos and engines, arranged so that the lighting service can be supplied independently. Perhaps the best example of this latter arrangement is the installation at Ackton Hall colliery, at Pontefract. At this colliery the generating plant consists principally of the 200 horse-power Parsons turbo-generators, delivering current at 220 volts, supplemented by three or four belt-driven dynamos, with separate engines of different patterns, of 20 horse power upwards. The supplemental smaller plant was really put down first, piece by piece.

A main switchboard is fixed in the main engine house, where the Parsons turbos are working. To it are brought all the circuits for lighting and for power, and to it also are brought the main cables from all the dynamos; measuring instruments, voltmeters for each dynamo,

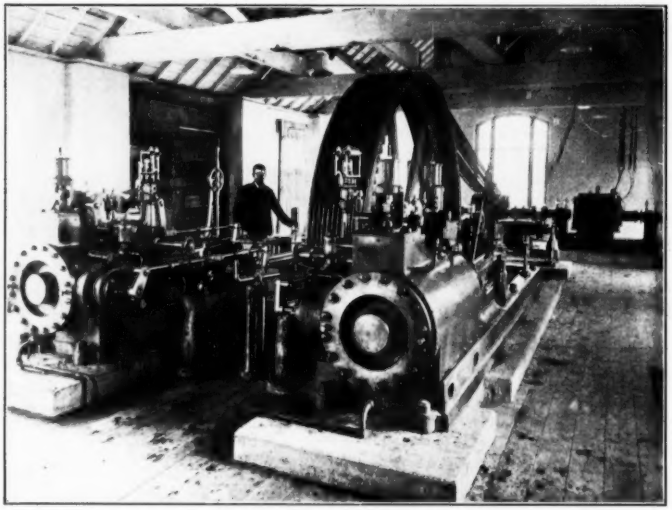
TURBO-ELECTRIC GENERATING HOUSE, ACKTON HALL COLLIERY.

and ampere meters for each dynamo and for each circuit, are also provided on the switchboard, and switches by means of which any circuit can be connected to or disconnected from any dynamo.

It will be seen that the engineer in charge of the plant has complete control of the whole apparatus. He can see at a glance what

current each dynamo is furnishing and what each circuit is taking, and can distribute the work accordingly.

At Trafalgar colliery, in the Forest of Dean, which was the very first to use electricity for power transmission, the following is the arrangement: One compound engine, capable of furnishing 260 horse power with 80 pounds' steam pressure at the stop valve, drives a separately excited dynamo, with a gramme-ring armature, capable of furnishing 150 amperes at 600 volts' pressure, when driven at a speed of 500 revolutions per minute. The driving is by means of nine ropes. Provision is made for driving a second dynamo of similar power



150 HORSE-POWER COMPOUND ENGINE, WITH ROPE DRIVE TO 600-VOLT 150-AMPERE DYNAMO, TRAFALGAR COLLIERY.

from the same engine. A smaller dynamo is also used to furnish current for the field magnets of the large dynamo, and a portion of the lights in use about the colliery. It works at a pressure of 100 volts, and is sufficiently powerful to furnish current for the pumping plant if required. The small dynamo is driven by a separate engine, by means of belts, through a countershaft. The dynamos and engines together furnish current for an electric-haulage plant of 90 horse power and two electric pumps, besides lights at the pit bottoms, the haulage and pump houses, and the surface arrangements.

The main-engine house is in telephonic communication with the

haulage-engine house, the pumps, and the end of the main haulage road.

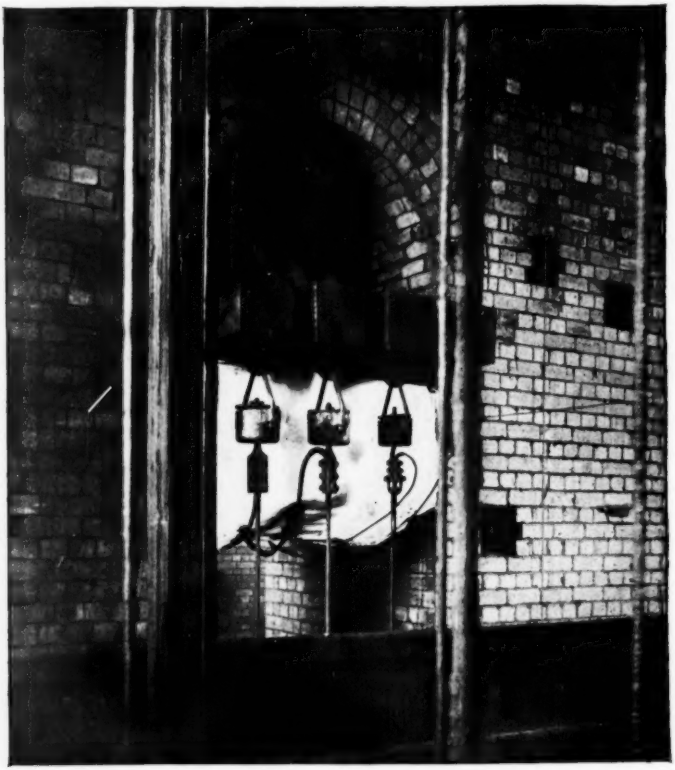
At Garswood Hall colliery, near Wigan, Lancashire, a three-phase dynamo and compound engine furnish current for lighting the whole of the surface arrangements at the colliery, including workmen's institute and reading rooms, for lighting underground, and for driving pumps and coal cutters, the Hurd coal cutter being the one employed.

Conductors for Distributing Current.—In the early days of the use of electricity for lighting or power, many mining engineers were anxious to economise in the matter of cables, by using some of the old wire ropes that were lying about their pit-tops, and many attempts were made with only one case where genuine success was attained, so far as I am aware, and even in that case, in my opinion, results as good would have been obtained if the same money had been spent on ordinary cables. It was found, as might have been foreseen, that the old wire rope had a very much higher electrical resistance than its dimensions would have indicated, on account of the fact that few of the wires of which the rope was composed were continuous for more than a few feet at most, conduction therefore only taking place across the surface from one individual wire to another. In the one successful case, the old ropes employed were very much larger than the work in hand appeared to need.

Naked copper wires have been, and are still, in use about the surface of coal and other mines, carried on porcelain insulators, sometimes of the oil type, and where open country has to be crossed, and they can be protected from mischief, they are quite safe.

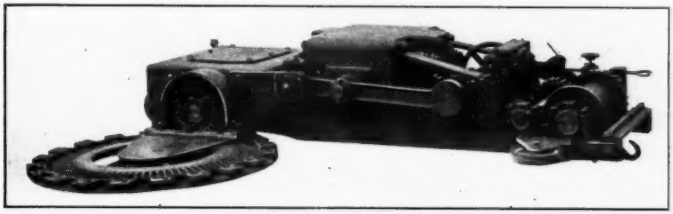
Also, in one case (at Ackton Hall colliery) Mr. Roslin Holiday, who laid out the installation, has used hard-drawn copper cables, only lightly insulated, stretched from top to bottom of the pit, to transmit the current to the pit bottom, the insulation being used merely to avoid shocks. He uses a form of insulator devised by himself, the cables being placed in a pit from which coals are not drawn. For the cables, both on the surface and underground, with the above exceptions, copper, covered with pure and vulcanised rubber, braided over all, is almost universally employed. Lead-covered cables have been tried, but in many mines the salts in the water, which is always present in the shaft, attacked the lead, which was also often damaged in fixing, with the result that the water penetrated to the insulation and the latter soon failed. The manufacture of lead-covered cables has improved very much of late years, the ability of the insulation

between the conductor and the lead having been considerably increased by not subjecting it to such high temperatures in the process of manufacture. It is also possible now to have thicker envelopes of lead, and still to have the cable as a whole very flexible, even in large sizes, so that, particularly in view of the continuous rise in price of India rubber, much more may now be hoped from lead and paper



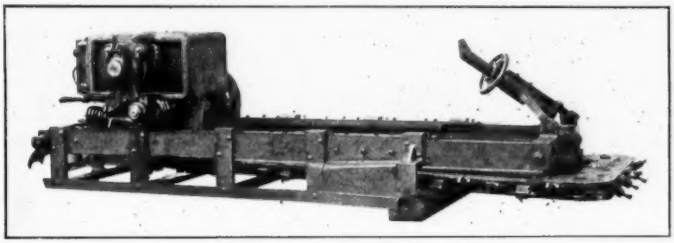
ENTRANCE TO SHAFT, ACKTON HALL COLLIERY. THE CABLES ARE SUSPENDED FROM MR. ROSLIN HOLIDAY'S SPECIAL FORM OF INSULATORS.

than has hitherto been obtained from lead and yarn, especially as the shaft cables are getting larger and larger as the use of electricity in mines develops. The shaft cables are always the most troublesome, and their effective protection from wet and from mechanical injury presents a somewhat difficult problem. It has been attacked with fair success in two ways:



ELECTRIC-DRIVEN LONGWALL COAL-CUTTING MACHINE.
By the Jeffrey Mfg. Co.

By having a very thick covering of rubber outside the conductor, and protecting that with a further thick wrapping of jute yarn thoroughly dried and impregnated with some water-resisting (so called waterproof) substance, with again tapes or braiding, also soaked in the same substance, outside all. This has been my method of solving the problem, the object being to give the water a good deal of work to do, requiring several years—ten or thereabouts—before the insulation is broken down, and at the same time to provide a substantial cable that will resist the knocks of small pieces of falling coal, etc. The other method, which has been adopted at several collieries, is to place iron pipes in the shaft, in lengths of 50 yards or thereabouts, the pipes being large enough to accommodate easily the two cables, which are insulated and braided in the usual way. At each 50 yards is an iron junction box, fitted water-tight to the pipe, with a junction board for the cables inside. The cables are drawn into the pipes, connected at the junction boards, and the covers of the boxes put on and red-leaded. The cost of this arrangement is considerable, and the weak point is the difficulty of making a clean, dry joint in presence of the water that nearly always runs down the shaft, and of preventing the water from getting into the joint box.



ELECTRIC-DRIVEN CHAIN MACHINE FOR COAL CUTTING.
By the Jeffrey Mfg. Co.

ELECTRIC-DRIVEN LONGWALL COAL CUTTER AT WORK IN AN ENGLISH COLLIERY.

By the Jeffrey Mfg. Co.

Water in the neighbourhood of an insulated cable, or where the cable is connected to some apparatus, is always a source of trouble, for two reasons:

The water softens the insulating material, depriving it of its insulating properties, and forms a path for the leakage current to "earth," to the body of the mine, and from cable to cable. This is the trouble most feared with cables for electric-light and power services, as after leakage and the consequent deterioration of the insulation often comes sparking, the formation of arcs, and kindred troubles.

But there is also another trouble, which is not much felt with large cables, but is often a serious matter with small ones—viz., the parting of the conductor, owing to the chemical action of the water upon the copper, aided by the current. This trouble is also sometimes met with, even with large cables, at joints and at connections to apparatus. If moisture is not rigorously excluded when the joint or connection is made, which is often very difficult to accomplish, and if it is not also prevented absolutely from entering the closed joint, or between the surfaces of the connections, chemical action takes place, leading to the gradual interposition of a fine layer of comparatively highly-resisting matter, which may seriously affect the working of the lights or the motors beyond. With a number of such connections, the results may be very serious.

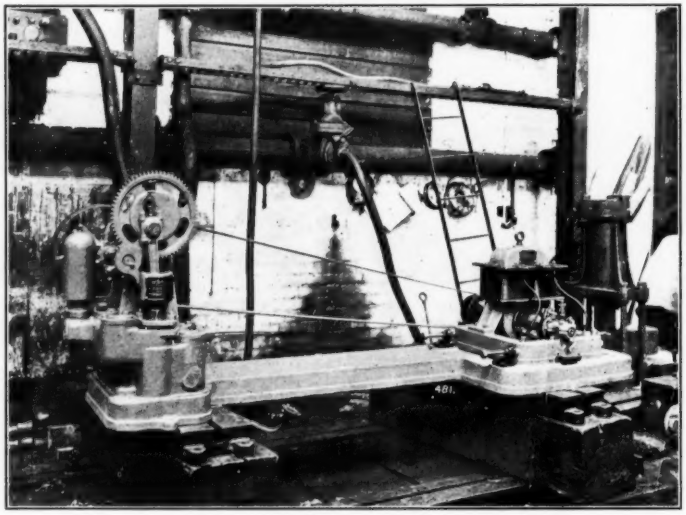
Two other uses of electricity may be mentioned. Electric welding has been employed to a small extent, at mines where a large generating plant exists. It is also used in the cyanide gold-recovery process, so much favoured on the Rand. Electricity finds, of course, in other mineral industries, applications which are closely related to those described in connection with coal mining. Whatever the product of the mine, the methods of working are all more or less adaptations of the methods employed in coal mines. There is always either a shaft, or a level, as it is termed, or adit, running into the mine. Wherever the ore has to be brought from a distance to the entrance of the mine there is always haulage of some kind, often small shafts or winzes, from one level to another. There is nearly always a quantity of water to be pumped out of the mine, and often from the workings. Machines are nearly always employed, worked by some form of mechanical energy, for drilling holes for the blasting charges and for cutting the ore itself. The mine and its accessories always require lighting. In all of these cases, the same practice is followed, to all intents and purposes, where it can be done economically, as with coal mines, and with the additional advantage that there are no gases to be fired in metalliferous mines, so that the electric motor, and the electric lamp, both supplied with energy by a pair of cables, often very small, that can be taken around corners, through airways, and into the most out-

ELECTRIC-DRIVEN LONGWALL COAL CUTTER AT WORK.

A side view of the machine shown on page 862.

of-the-way situations, are especially convenient. Electricity has been largely used for lighting, drilling etc., in the ironstone mines of Great Britain, and for lighting and motive power in the iron-ore mines of Spain, but it has, up to the present, been very little adopted in the Cornish tin mines, in fact, only for lighting the surface of some of the larger mines, such as Dolcoath.

Rock drills are very largely used in Cornish mines, but they are all worked by compressed air, which, in this case, has the very decided advantage over electricity that the air emitted by the exhaust cools the atmosphere of the level and assists a "not-too-good" ventila-



SMALL ELECTRIC MINING PUMPING SET, BELT DRIVEN.
By Ernest Scott & Mountain.

tion. Still I believe that, if other difficulties were overcome, Cornish mining engineers would find it advantageous to ventilate their deep levels by the aid of fans driven by electricity, the current for them being taken from one set of cables as in a coal mine.

The main difficulty, however, lies in the mine shaft. The shaft follows the lode, and the latter, though always tending downwards, often does so in a very erratic zig-zag fashion. In addition to this, Cornish mine shafts have usually a very large quantity of water constantly running down them, often strongly impregnated with metallic salts. Cables would, of course, follow the vagaries of the shaft easily

enough, but their maintenance might be a serious item, unless the matter was very carefully gone into and full provision made for protecting them both from the water and from jagged rocks. I venture to think the matter is well worth the consideration of Cornish mining engineers, and that, properly applied, electricity would enable them to compete on more equal terms with foreign mines.

The Economy of Electricity in Mining.—And now as to the reasons for the use of electricity. In the first place, its great convenience must be noted. An electric lamp can be placed and used where no other lamp can, and practically any candle power that may be required can be had from it. An electric motor to do certain work is much lighter and handier than any other form of motor, and the cables which feed it with energy are lighter, handier, more easily got into position, and more easily maintained than the pipes required for either steam or compressed air. The electric signal and the electric telephone will do what no other apparatus will. All these are sources of economy in themselves, and the busier the mine the greater the economies effected. But apart from these considerations, the electric motor and the electric system of transmitting power is far more efficient than any other system.

Dynamos and motors are now made with a standard efficiency of over 90 per cent., a figure which is utterly beyond the reach of the steam or compressed-air motor. And though two conversions of energy are necessary, from mechanical energy to electrical energy, and back to mechanical energy, the loss involved in the two, taking the efficiency of each at only 90 per cent., works out at 19 per cent., while the loss in the cables, which must be added to this, can be as small as the mine owner will pay for; the larger the cables, the smaller the loss.

It will be understood, of course, that the figures given—a loss of only 19 per cent., or a combined efficiency of dynamo and motor of 81 per cent.—refer to the efficiency of conversion from the driven shaft of the dynamo to the driving shaft of the motor. But by the aid of electric transmission of energy, some other economies become possible, and some are automatically realised. Thus, by delivering energy from one station for all the work of the mine, or of a group of mines, considerable economies of steam are possible. Higher steam pressures, themselves a source of economy if properly utilised, can be employed, and the steam itself can be used with the full benefit of the utmost limit of expansion.

And as to the economies that are realised automatically, these are due to two important properties of the electric current and the electric

motor. With steam or compressed air there are always losses in the pipes leading to the motors, due to loss of heat by the pipes, and there is a further loss at the steam or compressed-air motors from the same cause; and these losses are going on during the whole of the time that the engines may be standing, the losses from this cause being often very serious. With electric currents, so long as the cables are intact, they will always deliver the required energy to the motors, *instantly,* when called upon; they will deliver the energy exactly in proportion to the work the motors are required to perform, and there will be no loss, practically no charge of any kind, provided the cables are properly insulated, while the motors are standing.

The electric motor itself is also the most perfect governor that the skill of the engineer ever devised. It calls up and receives, instantly, the energy required to enable it to perform the work imposed upon it. When the work in front of it lessens, or ceases, instantly the call for energy is reduced in the same proportion. Farther, the electric motor gains in efficiency by the loss of heat, where the steam or compressed air motor loses. From all these causes, the use of electricity in mining is increasing, and will increase more and more as time goes on.

Mr. Walker desires to express his obligations to those who have assisted him with data and illustrations—especially to Messrs. R. S. Williamson, Frank Brain, Roslin Holiday, and W. O. Wood; to Messrs. Rosling & Appleby, John Davis & Son, The Uskside Engineering Co., Ernest Scott & Mountain, The Newton Electrical Works Co., The Allgemeine Elektricitäts Gesellschaft, The Sussman Electric Miners' Lamp Co., Johnson & Phillips, and the Nobels Explosives Co.

A SIMPLE AND PRACTICAL MEANS OF RECORDING STEAM-ENGINE PERFORMANCE.

By W. Ripper.

THE continued increase in the price of fuel and the consequent increase in the cost per unit of power produced in steam engines must inevitably lead, at no distant date, to a more frequent and more systematic examination of the daily working conditions in steam-power plants; for it is in the direction of improved conditions of ordinary daily working, rather than of improved design or construction, that we must look in the future for reduction in the cost per unit of power.

Referring at present to the engine itself, and leaving out of account the losses between the coal heap and the engine stop-valve, it may be safely stated that, before any great improvement can take place in the everyday performance of steam engines, some means must be available which will enable the steam user to know what is the actual performance of his power plant at any time, and how the performance at the moment compares with the best obtainable.

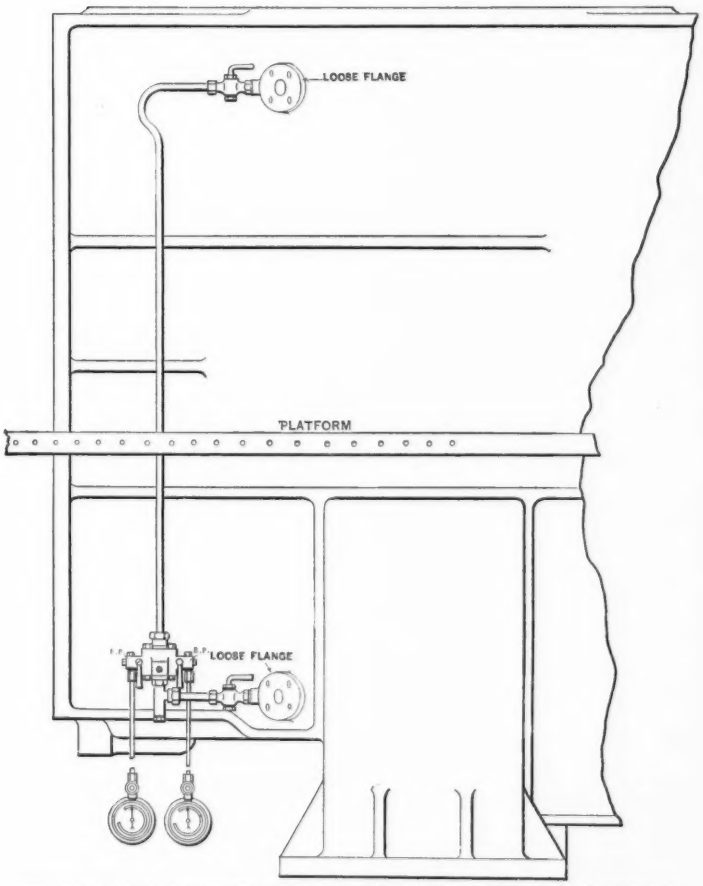
It is desirable that these results should not only be known, but that they should be systematically observed and recorded, so as to insure daily and even hourly information as to the working condition of the plant. Abnormal and costly methods of working are too often continued indefinitely, and all unnoticed, but by this means they would certainly be discovered, and steps could then be taken to avoid, so far as possible, these conditions in future.

Hitherto no such information has been available, however desirable it might be, because no simple and easily applied method of measurement has been found. The power of the engine has been obtained by the aid of the indicator, and the cost of the power in coal or steam consumption has been obtained by weighing the coal or by weighing the feed water or condensed steam. This method, however, involves the expenditure of much time and labour, to say nothing of skill and ability to make accurate measurements and calculations; and, though it is still the only method, if exact and minutely accurate results are required, it is not practicable for everyday purposes. For the close observation of the performance of the plant at any moment, and for a ready means of determining its behaviour from hour to hour, or from day to day all the year round, a simpler method is desirable.

Usually the minimum steam consumption of engines per unit of power is specified by the purchaser, and guaranteed by the maker, always with the understanding that these minimum results are obtained when the engine is worked under its best conditions; but what the cost in steam consumption per unit of power is, when the engines are worked under conditions other than the best, is probably not known to either maker or user. If those who have to pay the coal bill had a ready means of observing how great the difference may be between working a plant under good and under bad conditions, more care would certainly be taken to keep as far away from the latter as possible. Thus, to take the case of a certain high-class high-speed engine, whose performance I now have before me: Calling its steam consumption per unit of power 1.0 when working at full load, when working at one-quarter load the steam consumption per unit of power was 1.6—that is, an increase of 60 per cent. in the cost per unit; and if this latter condition of things were continued indefinitely, it is clear that there is something wrong with the relation between the power of the engine and the work it has to do, and the sooner a change is made the better for the economy and efficiency of the plant.

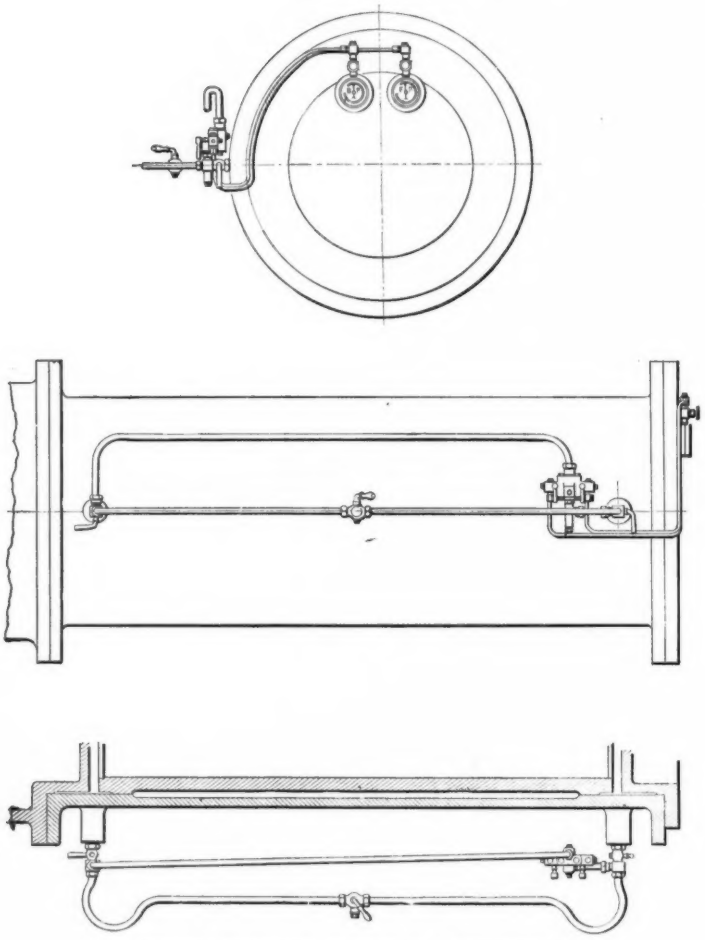
In order to obtain the information required there are two separate facts to be determined: first, the power of the engine at any moment, and second, the steam consumption of the engine at the same moment; and the problem is, how to obtain these results directly and without elaborate measurements or calculations. For this purpose I have devised an arrangement, by means of which these values may be obtained with fairly close approximation to accuracy by means of pressure-gauge readings. This apparatus, it will be seen, has its limitations, but for a large number of ordinary cases in practice it is directly applicable.

1. Power of the Engine.—To find the actual horse power we require, first, the mean effective pressure of the steam in the cylinder; and then, having counted the revolutions per minute, the horse power may be immediately obtained by calculation. But for all practical purposes, especially where the revolutions are approximately constant, it is sufficient to know the mean effective pressure alone, from which we obtain at once a knowledge of the relative power exerted by the engine. To find the mean effective pressure, the instrument illustrated on page 875, and called a "Mean-Pressure Indicator" is used. There are, it will be seen, in the first place, two pressure gauges, the first of which (A) gives the mean effect of the driving steam pressure, and the



METHOD OF ATTACHING MEAN-PRESSURE INDICATOR TO CYLINDER OF A VERTICAL ENGINE.

second (B) the mean effect of the back pressure. The difference between these two readings gives the mean effective pressure on the piston. These continuous readings on the respective gauges are obtained by the use of two valves, as shown in the figure; thus, when the steam is driving the piston downwards, it enters at the same time the valve box of the instrument, closing the ball valve to the bottom side, and communicating its pressure directly to the gauge A. At the same time the double beat valve is closed on its top side and opened at the



MEAN-PRESSURE INDICATOR ATTACHED TO A HORIZONTAL ENGINE.
The end view of the cylinder is shown in the uppermost figure.

bottom, thus placing the exhaust side of the piston in communication with gauge B. On the reversal of the pressures at the return stroke the same gauges again receive the respective forward and back pressures as before. At the recent trials of the new Cunard steamship Saxonia on the Clyde, the engines were fitted with this instrument.

Being a twin-screw ship she had two sets of quadruple expansion engines, and one instrument was fitted to each of the four cylinders of one set of engines. Indicator diagrams with ordinary indicators were also taken throughout the trial. The results obtained with this instrument, as compared with those with the ordinary indicator, are seen by the following table:

CUNARD LINE. S. S. SAXONIA. TRIAL TRIP, APRIL 25, 1900.

Time, 2.57 P. M.	H. P. Cylinder.	1st. Inter. Cylinder.	2d Inter. Cylinder.	L. P. Cylr.	Total M. E. P. Referred to L. P. Cylr.
M. E P. from Indicator Cards..	70.0	45.5	21.0	10.8	40.2
M. E. P. by Gauge Readings of Instrument.....	70.0	46.5	20.8	10.5	40.0

With this instrument it is thus possible to see continuously and without the necessity of taking indicator diagrams, what is the condition of the engine, whether it is working full power, or half or quarter power, whether the conditions are constant or variable, and what the actual mean effective pressure is in each cylinder of the series in compound, triple, or quadruple-expansion engines.

To show further at a glance not only what the power is in each cylinder, but what the total is when referred to one common standard, namely, the "mean effective pressure on the low-pressure piston," I have devised a "Power Board" (see page 873), to which the mean-pressure reading from the gauges is transferred and recorded in much the same way as a billiard player's score is recorded by a billiard marker by moving a pointer along a scale. There are as many grooves with sliding buttons as there are cylinders in the engine, and the pointers then show, for each cylinder of the set, what is the mean effective pressure in the cylinder, and also (by using a double pointer to each button), what its equivalent is when referred to the low-pressure piston. By this arrangement it is easy to sum up the results on a slip of paper by the side of the scales and obtain at once the mean effective power of the engine "referred to the low-pressure piston." At the same time, also, we may see at once how the power is distributed among the various cylinders of the set. The pointers are adjusted in their respective positions after taking the mean-pressure readings from the respective gauges. The scales for the successive cylinders bear the same ratio to each other as their respective piston areas.

Sheet No. ____ **Power Record (Ripper's Mean Pressure Indicator)** Schäffer & Budenberg, Manchester, London & Glasgow.

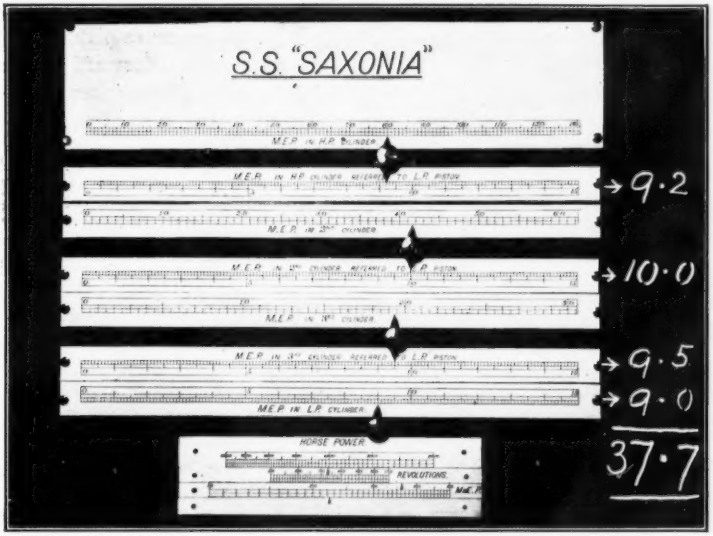
Date 190

Time	H.P. Cylinder				I. Cylinder				I. Cylinder				L.P. Cylinder			Total		* Steam Consumption Factor	Rev. per Min.	I.H.P.	Remarks
	F.P.	B.P.	Diff.	Referred to L.P.C.	F.P.	B.P.	Diff.	Referred to L.P.C.	F.P.	B.P.	Diff.	Referred to L.P.C.	F.P.	B.P.	Diff.	Referred to L.P.C.	+ ⅛ correction				

* Steam Consumption Factor per Unit of M.E.P. = $\frac{\text{Absolute pressure of F.P. gauge on L.P. Cylinder.}}{\text{Total M.E.P.}}$

RECORD SHEET FOR USE WITH MEAN-PRESSURE INDICATOR.

Many compound engines run continuously with the power most unevenly distributed between the cylinders, in which case such engines are like a team of horses with one horse bearing more than its own share of the load. The remedy for such a condition of things is in the first instance to be made aware of its existence, instead of, as at present is too often the case, to be going on from month to month quite in the dark as to the detailed performance of each engine of the set. When the fact is plainly to be seen continuously, as with this apparatus, it is usually an easy matter to remedy the defect and to distribute the work evenly.



POWER BOARD AS USED ON CUNARD STEAMSHIP SAXONIA.

2. Relative Weight of Steam Expended per Unit of Mean Effective Pressure.—The relative weight of steam used per stroke is obtained from the reading of a pressure gauge on the assumption that the weight of steam used by an engine (neglecting cylinder condensation), is proportional to the mean absolute pressure of the steam on the driving side of the low-pressure piston. It is, of course, more truly proportional to the absolute terminal pressure of the steam at the end of expansion in the low-pressure cylinder; but it is known that in all throttling engines, and in the low-pressure cylinders of practically all types of condensing engines, the mean absolute forward pressures

vary in the same ratio as the absolute terminal pressures.* Hence, if the readings of the forward mean-pressure gauge of the instrument on the low-pressure cylinder be taken at various loads, those readings in absolute pressure express proportionally the steam consumption of those loads.

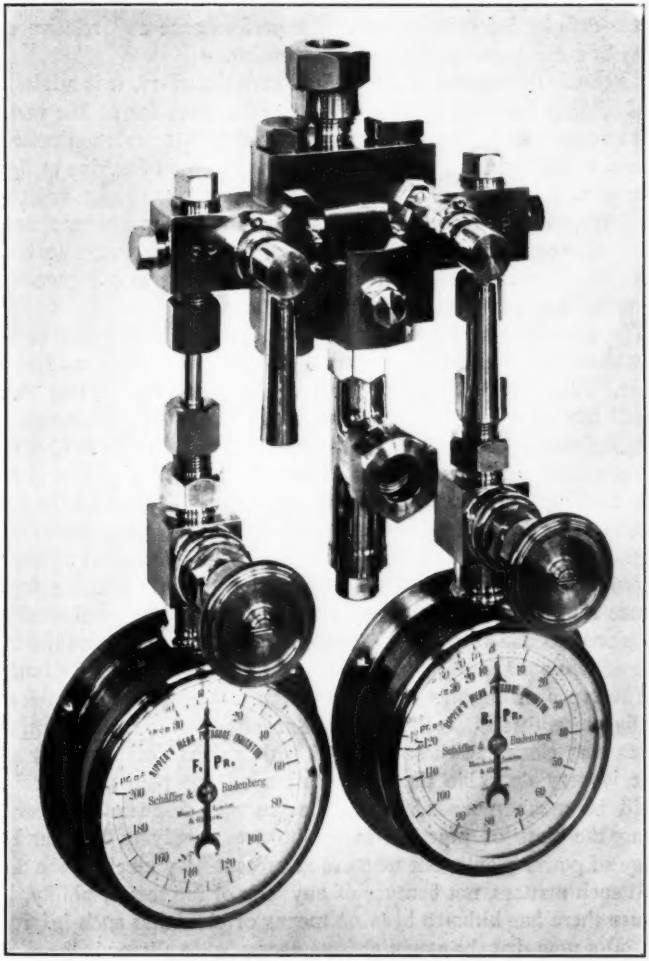
In order to relate the steam consumed with the power of the engine, it is only necessary to divide the forward-pressure readings of the low-pressure gauge by the total mean effective pressure of the engine referred to the low-pressure piston. This result will express in terms of steam consumption the relative cost per unit of mean effective pressure exerted. Thus, taking the case of the Saxonia, the total mean effective pressure referred to the low-pressure piston during one of the trials was 44; the mean pressure by the forward gauge of the low-pressure cylinder was 15; then the factor of steam consumption per unit of mean effective pressure is $15 \div 44 = 0.34$. In a triple-expansion engine with the total mean effective pressure referred to low-pressure piston equal to 39, and the mean pressure of the forward gauge of the low-pressure cylinder equal to 17, then the steam consumption per unit of mean effective pressure is $17 \div 39 = 0.436$. Again, for a two-cylinder compound condensing engine with a total mean effective pressure referred to low-pressure piston equal to 35, and the mean pressure of the forward-pressure gauge of the low-pressure cylinder equal to 21.5, then $21.5 \div 35 = 0.6$; and the relative cost per unit of mean effective power in these three types of engines is as shown in the following table:

STEAM CONSUMPTION PER UNIT OF MEAN EFFECTIVE PRESSURE.

Quadruple Expansion.	Triple Expansion.	Double Expansion.
0.34	0.436	0.6

Again, referring to the two-cylinder compound condensing engine: Suppose this engine is worked at half-power, with a mean effective pressure referred to low-pressure cylinder of 18; then the reading by the forward pressure gauge of low-pressure cylinder is 12, and the steam consumption per unit of mean effective pressure is $12 \div 18 = 0.67$. When worked at the normal load of 35 mean effective pressure, its factor of steam consumption, as we have seen from the

* Absolute pressure is pressure reckoned from perfect vacuum, and not from atmospheric pressure.



CONTINUOUS MEAN-PRESSURE INDICATOR.

One dial records the mean forward pressure, the other the mean back pressure, the difference giving the mean effective pressure.

table, was 0.6; so that, comparing the normal load with the lower load, the ratio of steam consumption is as 0.6 is to 0.67, or an increase of 11.67 per cent. of steam per unit of power, when working at one-half the normal power.

These examples will be sufficient to illustrate the possibility of obtaining definite information as to the performance and relative efficiency of a steam-power plant at any moment.

As to the limitations of the method here described, it is advisable, for absolutely accurate results, to standardize once for all the instrument against a good ordinary indicator, and find the relation between the two sets of results for the given engine or type of engine at light, medium, and heavy loads. For mill engines no correction is necessary for the low-pressure cylinder, but for the high-pressure cylinder with a very early cut-off and a good compression the instrument will read about 5 per cent. *high* at 0.2 cut-off, varying to 0 per cent. at 0.5 cut-off, and to 2½ per cent. *low* at 0.7 cut-off.

The engines which present the most difficulty in the use of this instrument are the locomotive and the compound non-condensing engine. Both these engines have a large compression. When working at high loads the differences are small, but when working at low loads, with early cut-off and high compression, the effect is to throw a portion of the early compression upon the steam side of the instrument, causing the forward-pressure gauge to read high and the back pressure to read low, and the engine is credited with more power than it actually exerts; but even in these cases, if the instrument be standardized for different positions of the link, and the correcting factor be once found for the full range of notches under the usual working conditions, no difficulty will be found in obtaining therefrom the true mean effective pressure by using the necessary factor of correction.

The types of engines employed on large power plants, however, usually present no difficulties, and the results obtained with them approach very closely to those obtained with a good ordinary indicator.

It is very desirable that information on the points here raised should be much more commonly known and discussed, especially among the class of practical men who are usually to be found in charge of power plants, but who are at present very much in the dark on all such matters, not because of any lack of interest or ability, but because there has hitherto been no means of obtaining such information. But now that the essential facts necessary to a knowledge of the relative efficiency of the engine at any moment can be easily determined, we may look for a considerable increase of attention to the subject, a systematic recording of results, improved condition of working, and a consequent reduction in the cost per unit of power.

THE LOCOMOTIVE EXHIBIT AT THE PARIS EXPOSITION.

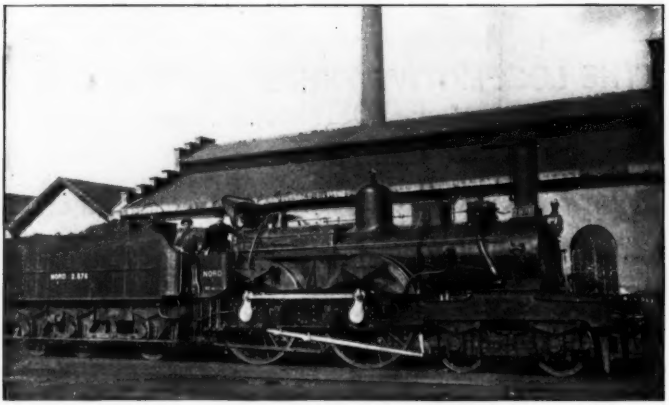
By Charles Rous-Marten.

IT is much to be regretted that considerations of space led the Paris exhibition authorities to banish the magnificent show of railway rolling-stock to the remote suburb of Vincennes. That the Bois de Vincennes and its island-studded lake are supremely beautiful, nobody with a particle of taste will attempt to deny. But the pity is all the greater that it should have been decided to mar that exquisite park by intruding a number of ugly buildings. And the visitor interested in locomotives feels it to be no less a grievance that he should be required to make a pilgrimage to such an out-of-the-way locality.

It is very difficult to get to Vincennes with anything like celerity. You have to allow fully an hour from the centre of Paris. Perhaps an omnibus to the Bastille and electric tram thence is the best way, unless you can tempt a cabman with double fare or more to take you thither, for if you call a cab in the street the driver simply won't take you if you say you want to go to Vincennes; you must find a cab on some regular stand—not always an easy task in exhibition time. However, when at last you do reach Vincennes and enter the plain but vast and singularly convenient and well-lighted shed in which the railway rolling-stock is displayed, you soon forget the annoyances of transit in the interest which meets you on all sides.

For it is a splendid show—there can be no two opinions about that. So great and varied a collection of fine locomotives and vehicles can hardly have been brought together ever before. And assuredly there has never been any previous exhibition which displayed so imposing an array of giants among locomotives. It is all the more to be regretted that the completion of the catalogues—so needful for the adequate study of the numerous novelties—should have been delayed for months after the opening of the exhibition, and that the means of ob-

Mr. Rous-Marten's articles on British and American practice in locomotive construction, which appeared in THE ENGINEERING MAGAZINE during the summer of 1899, were among the most widely-noticed papers ever published in these pages. In this review and the one to follow in our October number he extends the discussion over a still larger field, using the typical exhibits at the Paris Exposition as the basis of a broadly international comparison of leading tendencies in locomotive building.—THE EDITORS.



TYPICAL FRENCH LOCOMOTIVES. NON-COMPOUND EXPRESS ENGINE, CHEMIN DE FER DU NORD.

"Type Outrance," predecessor of the four-cylinder compound.

taining on the spot adequate information touching the various exhibits, other than those of British or American or French origin, are lamentably deficient—or at least were so at the time of my latest visit. This has made the task of due examination very difficult, and also involves much delay.

Reviewing this section of the exhibition as a whole, I think the points which strike one most forcibly are:

(1) The enormous preponderance of the compound type of engines over the simple high-pressure type.

(2) The comparative scarcity of eccentricities in design.

(3) The immense increase in size and weight of locomotives since the last exhibition.

(4) The specially huge size and power of certain Russian engines.

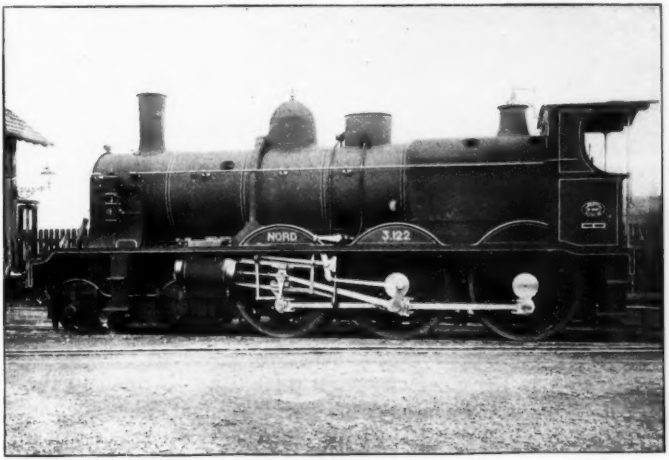
(5) The almost universal employment of coupled wheels in express engines, and the consequent all but complete disappearance of the single-driver type.

(6) The large augmentation of heating surface and of steam pressure.

These were the points which struck me most in my general survey of the exhibition. On the whole, they represent the principle of development in locomotive practice. They tend in the direction of increased haulage power, rather than in that of any attempted addition to existing possibilities in respect of maximum speeds. It is doubtful whether any locomotive shown at Vincennes has a much higher capac-

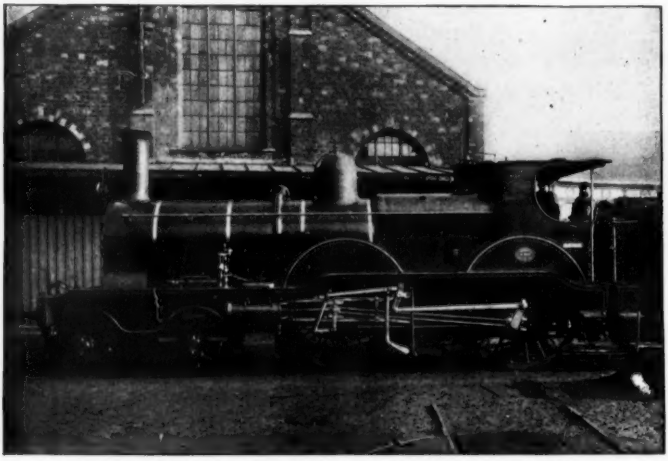
ity in respect of mere speed than had the Great Western engine with 8-foot single driving wheels, designed by Sir Daniel (then Mr.) Gooch and shown in the London exhibition of 1851, or than the newer 8-foot single-wheeler shown by Messrs. Neilson & Co., of Glasgow, eleven years later. At all events, if any of the most recent engines have higher speed capacity, this is due solely to the increased steam pressure employed and not to any other modification of design. The fact is that locomotive engineers are, as a rule, satisfied with the maximum speeds which have proved feasible during the past decade, and have set themselves rather the problem of hauling heavier loads at those speeds than that of accelerating the mere velocities obtainable.

This is particularly noticeable in the case of the locomotives built for service on the European continent, where maximum speeds are limited by law with extreme precision and strictness, and where the observance of those statutory limitations is enforced with stern severity. There must be no attempts to attain 90 or 100 miles an hour, as in America and Great Britain, save in special experimental trials expressly authorised and fenced round with elaborate precautions. All over Germany and Belgium, and, I believe, also in Holland and Austria-Hungary, the maximum speed is rigorously limited to 90 kilometres (or about 56 miles) per hour. I understand that a similar restriction exists on the Etat Railway of France and it also does—or did until very recently—on the French Western line. For a long time the



TYPICAL FRENCH LOCOMOTIVES. TEN-WHEELED FOUR-CYLINDER COMPOUND LOCOMOTIVE, CHEMIN DE FER DU NORD. NEW SIX-WHEEL COUPLED TYPE.

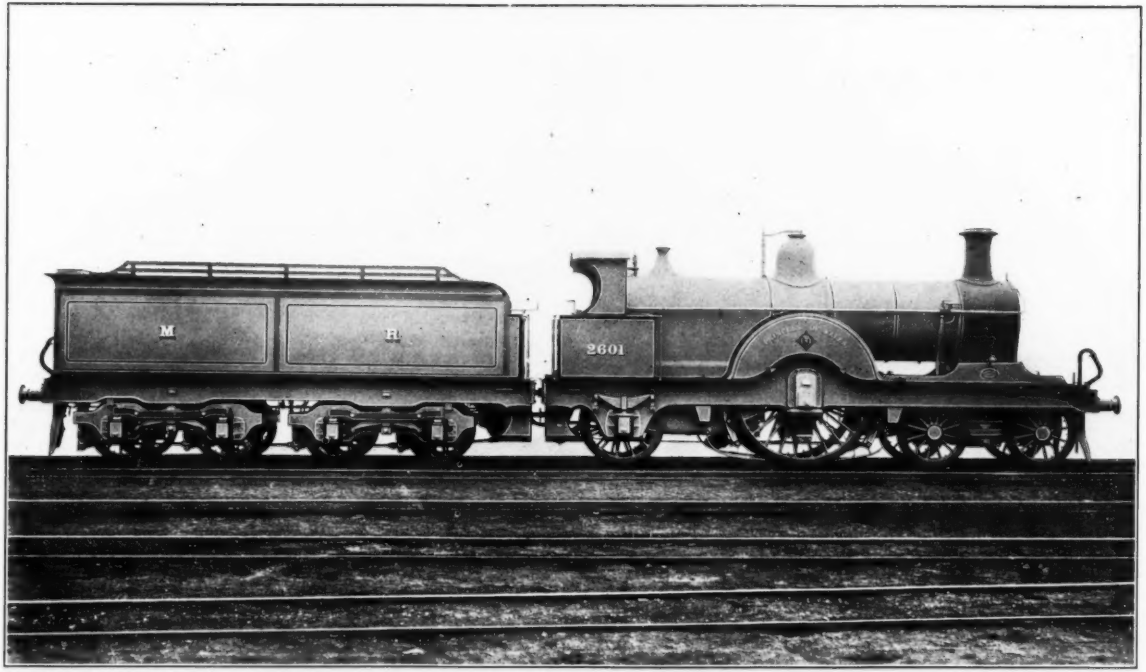
Chemin de Fer du Nord stood alone in France in being permitted to run at 120 kilometres—74.5 miles—an hour, but this is now sanctioned also on the Orleans, Est, and Midi lines. The Orleans Railway was limited to 112½ kilometres—70 miles—an hour, up to little more than a year ago, and the Paris-Lyon-Mediteranée to 100 kilometres—62.1 miles—an hour. I believe that on the latter railway this limit has lately been extended, and on the Nord line a speed of 125 kilometres—or 77.6 miles—may be run on special occasions by direct permission. But the principle of restriction holds good over the entire European continent. The limit may be 77.6 miles an hour, as in the single exceptional case just quoted, or it may be 74.5 miles, as in those and a few other instances, or 55.8 to 62.1 miles, as on the large majority of



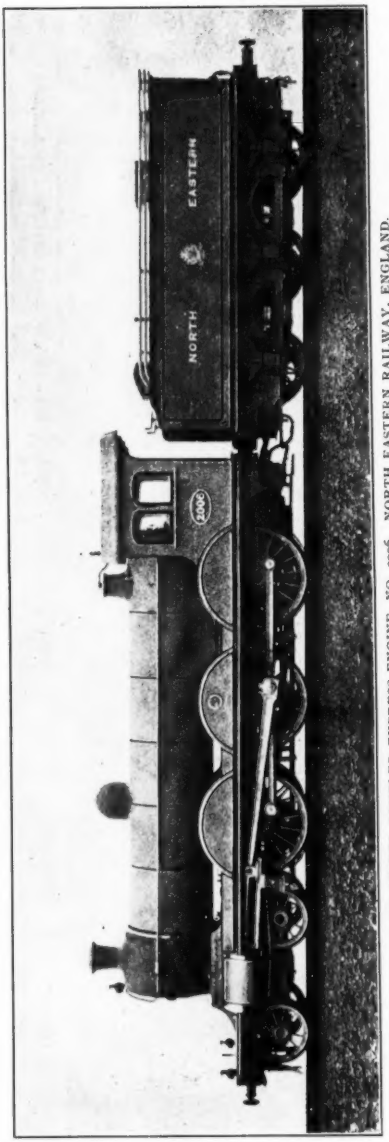
TYPICAL FRENCH LOCOMOTIVES FOUR-CYLINDER COMPOUND EXPRESS ENGINE, CHEMIN DE FER DU NORD.

European lines. But the limitation is always there and cannot be evaded without the risk being incurred of heavy penalties. In America and Great Britain no such restrictions exist, and the latter country accordingly presents in its exhibits the sole exception to more than one of the principles which I have indicated as generally prevalent among the locomotives shown in 1900.

Indisputably the chief exception offered by England to the rule of modern locomotive practice as exemplified at Vincennes in this year, the hundredth and last of the nineteenth century, is that of the Midland exhibition engine, which is the sole instance of a single-driver engine among all that crowd of express engines present. Even



SINGLE-DRIVER EXPRESS ENGINE "PRINCESS OF WALES," NO. 2601. EXHIBITED BY THE MIDLAND RAILWAY, ENGLAND.
Designed and built at the company's works, Derby, by Mr. Samuel W. Johnson, chief mechanical engineer.



SIX-WHEEL COUPLED EXPRESS ENGINE, NO. 2006. NORTH EASTERN RAILWAY, ENGLAND.
Designed and built at the company's works, Gateshead, by Mr. Wilson Worsdell, chief mechanical engineer.

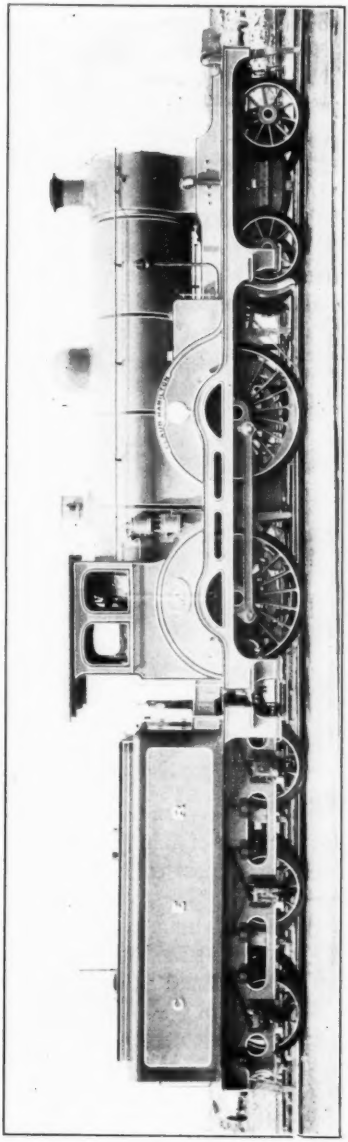
among the four locomotives of purely English design, which, I regret to say, constitute the entire display in the British section, this Midland engine, "Princess of Wales," No. 2601, is the sole single-wheeler. The Great Western and London & North Western exhibits are coupled express engines, and the North Eastern is not only coupled but six-wheel-coupled as well.

Now this is in itself a fact of such important significance as concerning the present tendency and drift of modern locomotive practice, that I have selected it as the first among the characteristic principles which govern the present exhibition of locomotives. But the question is: Of *what* is the fact significant? What conclusions are we to deduce from the circumstance that only this one single-wheeler is to be found in the present exhibition?

Naturally, the reply given upon impulse would be that it implies the virtual extinction of the single-driver type at no distant date. But is this so? Let us see.

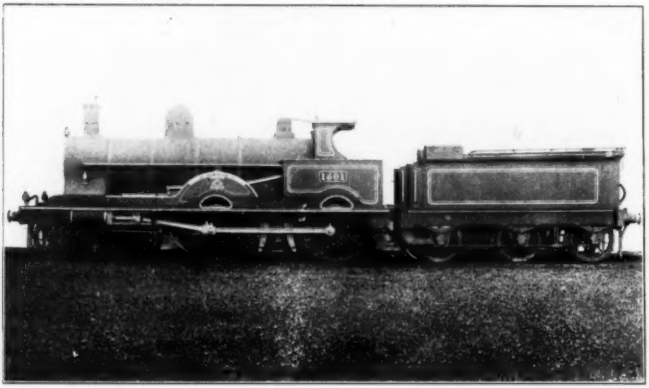
It is a curious feature in this problem that the sole

representative of the once-universal single-driver type for express duty is designed by an engineer—one of the most eminent in England—who for many years, in fact up to the year 1885, set his face utterly against the use of that type in any circumstances or under any conditions. While the Great Western, Great Eastern, and Great Northern Railways were turning out single-wheelers in large numbers and claiming for them distinct superiority on fast express work, Mr. Johnson continued calmly to build nothing but coupled locomotives for that same class of duty, although his trains were timed quite as fast as those worked by single-wheelers, and in some cases even faster. But all that time Mr. Johnson had not been unobservant of the excellent work eccomplished with ease and marked economy by the Great Northern and Great Western single-wheelers. So when, by the introduction of the Gresham sand-blast, slipping—that objectionable propensity of single-driver engines and their most serious drawback—was reduced to a minimum, Mr. Johnson brought out a new type of single-wheelers. which, although it has under-



FOUR-COUPLED LIQUID-FUEL-BURNING EXPRESS ENGINE, NO. 1900. GREAT EASTERN RAILWAY.
Designed and built at the company's works, Stratford, by Mr. James Holden, chief mechanical engineer.

gone five successive developments, of which the latest is to be seen in the beautiful engine at Vincennes, yet remains the same in all but relatively minor details. Nos. 25-29, the earliest numbers of the now numerous class, had 18-inch cylinders, 26-inch piston-stroke, and 7 foot 4 inch single driving-wheels. No. 1853—prize winner in the Paris exhibition of 1889—and her sister-engines, had 18½-inch cylinders and 7 foot 6 inch-wheels. No. 79, etc., had 19-inch cylinders; No. 115, etc., had 19½-inch cylinders and 7 foot 9 inch-wheels, and finally No. 2601, with the same-sized cylinders and wheels, has a larger fire-box, higher steam pressure, and a double-bogie tender. But the type is the same, persistent throughout. Thus the fact that Mr. Johnson brings out in 1900 a

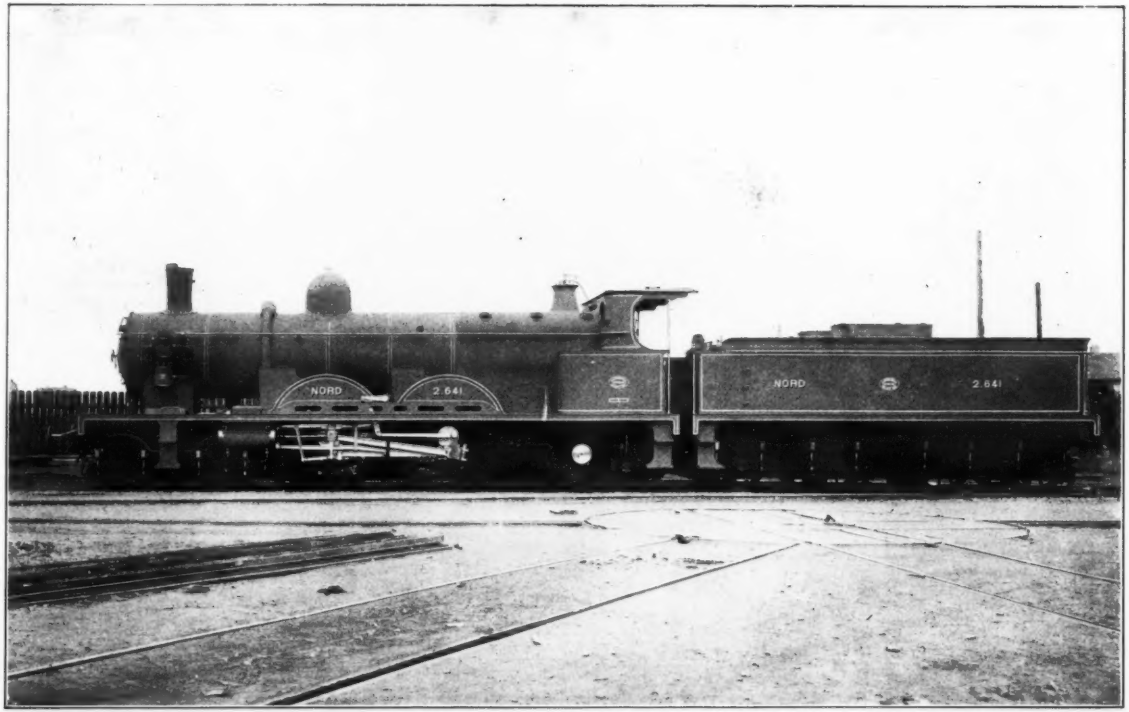


FOUR-CYLINDER COMPOUND FOUR COUPLED ENGINE "JUBILEE," DUPLICATE OF THE ENGINE "LA FRANCE."

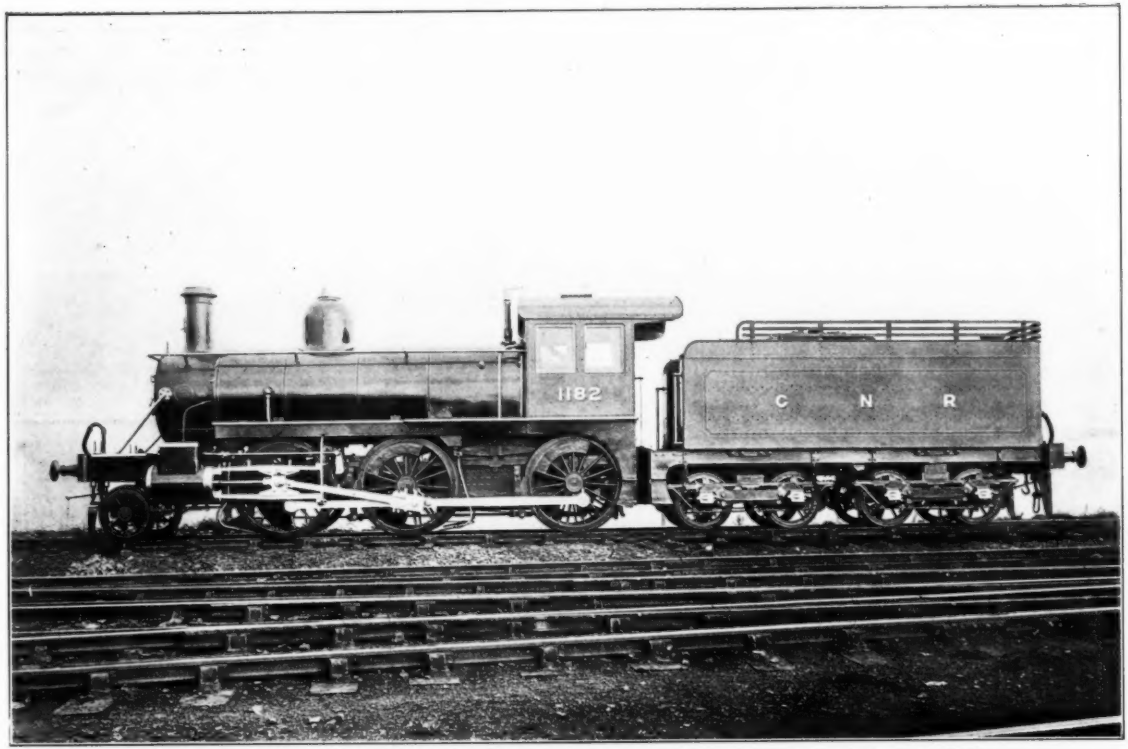
Exhibited by the London & North Western Railway, England; built at the company's works, Crewe, by Mr. F. W. Webb, chief mechanical engineer.

new development of this type must at least be accepted as evidence that one of the most eminent of British locomotive engineers does not regard the single-driver type as archaic or obsolete, but, on the contrary, sees in it a potentiality of much continued usefulness if employed upon work suited to its special idiosyncrasies.

Nor does he stand alone in this view, if one may judge an engineer's principles by his actions, the tree by its fruits. For Mr. H. A. Ivatt, the able chief mechanical engineer of the Great Northern Railway, who, like Mr. Johnson, has built and continues to build large numbers of fine express engines with coupled wheels, has quite recently turned out two remarkably excellent specimens of express single-wheelers. So has Mr. Harry Pollitt, chief mechanical engineer



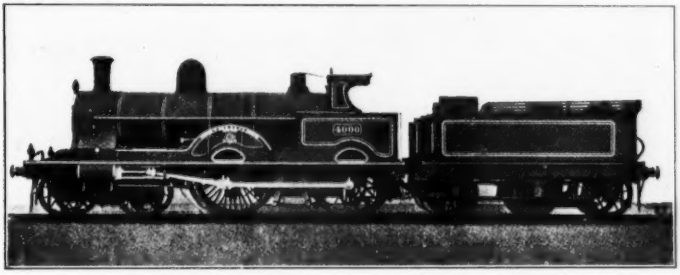
FOUR-CYLINDER COMPOUND FOUR-COUPLED EXPRESS ENGINE. NO. 2641, CHEMIN DE FER DU NORD, FRANCE. DE GLEHN COMPOUND SYSTEM.
Designed by M. du Bousquet, ingénieur en chef du material et de la traction, and built by the Societé Alsacienne de Constructions Mécaniques, Belfort.



GOODS ENGINE NO. 1182. DUPLICATE OF THE ENGINE NO. 1200. GREAT NORTHERN RAILWAY OF ENGLAND.
Built by Messrs. Burnham, Williams & Co., Baldwin Locomotive Works, Philadelphia, Pa., and exhibited by the builders.

of the Great Central line. Had the Great Northern and the Great Central companies cared to exhibit at Vincennes, it is highly probable that they would have sent their latest single-wheelers as their newest and most interesting types.

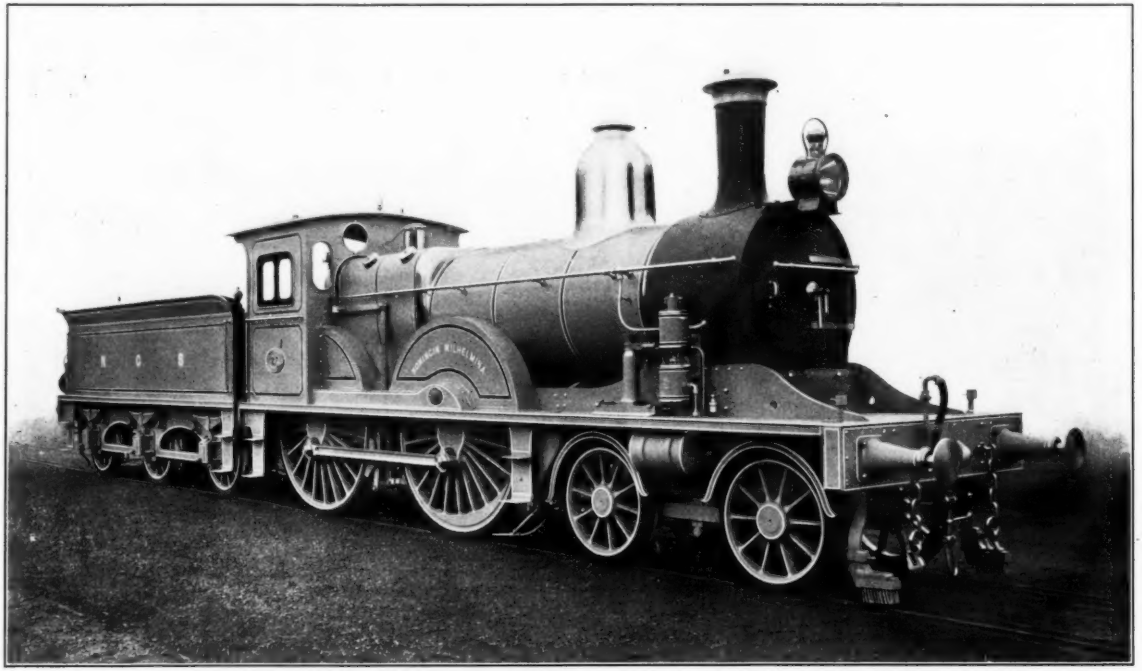
But, on the other hand, there is the adversely significant fact that the Great Eastern, which has been one of the three most consistent votaries of single-wheelism since its earliest days, and whose present able locomotive superintendent, Mr. James Holden, brought out only two years ago an entirely new single-driver type, is represented this year at Vincennes by a coupled express engine—a magnificent one, too. And, further, Mr. Holden himself informed me at Vincennes that on mature consideration he did not intend to build any more single-wheelers. It is an interesting coincidence that the last time I met Mr. W. Dean, chief mechanical engineer of the Great Western



FOUR-CYLINDER COMPOUND FOUR-COUPLED EXPRESS ENGINE NO 4000, LONDON AND NORTH WESTERN RAILWAY, ENGLAND.

Designed and built at the company's works, Crewe, by Mr. F. W. Webb, chief mechanical engineer; exhibited by the company.

Railway—a line which has never hitherto wavered in its preference for the single-driver type in express service—he informed me that, in view of the performances of his latest coupled type, he too would construct no more single-wheelers. Neither F. W. Webb nor Mr. Wilson Worsdell, the chief mechanical engineers of the only other British railways exhibiting at Vincennes, has ever built any single-wheelers at all for his line, although each has rebuilt and improved construct no more single-wheelers. Neither Mr. F. W. Webb nor Mr. Pollitt, who built the new single-wheeler for the Great Central, has just retired from his position, and his successor's antecedents rather discourage the idea that he will perpetuate the type, it would appear that Mr. Johnson and Mr. Ivatt will be the only British engineers to continue building single-driver locomotives, and thus the almost total absence of the type from the Vincennes show is, as I remarked at the



FOUR-COUPLED EXPRESS ENGINE "KONINGIN WILHELMINA." STATE RAILWAYS OF HOLLAND.
Built by Messrs. Neilson, Reid & Company, Hyde Park Works, Glasgow, and exhibited in the British section by the builders.

outset, distinctly significant of a predominant tendency in British locomotive-building practice.

A second prominent exception offered by Great Britain, the motherland of railways, to the tendency of the whole world outside her boundaries, consists—if I may take her Vincennes exhibit as the criterion—in her disinclination to adopt the compound principle for locomotives. Of the four purely British exhibits, only one is constructed on the compound system, the engine "La France," No. 4000—she being the four-thousandth locomotive built at the famous Crewe works of the London & North Western Railway Company. All the rest are non-compound. Among the exhibits of all other countries, the proportion of compounds to non-compounds is, I should think, quite 10 to 1, if not more. This strange discrepancy in national practice raises another question, and a large one, which I must leave to be dealt with later.

Meanwhile, pursuing my plan of noticing first, in my general review, the prominent exceptions to prevalent locomotive-practice, I must mention two engines of a most extraordinary character which I am unable to treat fully on this occasion, but which I hope to describe and illustrate in a subsequent article. One of these is so singular in the salient feature of its design that, had not the idea been indignantly repudiated by its designer, one would have felt impelled to regard it as a huge scientific practical joke. It is a four-coupled compound express engine built by Krauss, of Munich, for the Bavarian State Railways. It may be described as quasi-"Atlantic" in its type, having a small pair of carrying wheels behind the fire-box, two pairs of large coupled driving-wheels and a four-wheeled leading bogie. The cylinders are inside, but that is a mere detail. The astonishing peculiarity of this engine is that its two pairs of bogie wheels are placed so far apart as to admit between them a third pair of wheels, 3 feet 3¾ inches in diameter, and that this third pair is driven by a pair of small outside cylinders, the combination producing what is called an "auxiliary" engine—equivalent to the "donkey" on board a steamer. Further, this pair of small auxiliary drivers can be raised from the rails, or pressed upon them, as desired, by means of a lever. The object of this eccentric appliance has proved a tough puzzle to most visitors. One, a British engineer of no mean standing, hazarded the conjecture that the tiny auxiliary wheels and cylinders were to be used to move the locomotive about the yard, so as to give the big wheels and cylinders a rest. This suggested to him a humorous comparison with Sir Isaac Newton's absent-minded provision of a large

aperture in the door for his large dog to pass through, and a small aperture for the small dog! Naturally the designer was outraged at so disrespectful a reference, and he promptly explained that his "real intention is to have a locomotive, which, in general, has the qualities of a four-coupled engine, but is able to increase, every time it is needed, its cylinder power as well as its adhesive weight in the proportion of 3 to 2, so that it can exert temporarily a tractive power corresponding to six-coupled wheels. In such cases, viz., in starting and accelerating heavy trains, or in ascending steep gradients, the auxiliary axle can be pressed down, its cylinders switched in, and the small engine used as a pilot for the main one. As the assistance of the auxiliary engine can only be wanted at a limited speed, say at the most 65 kilos. (40 miles) an hour, the diameter of its drivers can be made considerably smaller than that of the main drivers."

I must leave this matter for the present, as in this article I am taking merely a general survey of the exhibition and its salient characteristics. But clearly the point is one upon which a good deal can be said.

The other locomotive which struck me as prominent among the relatively few eccentricities of design was the huge six-coupled express engine built at the Florence Works of the Adriatic Railway of Italy, and numbered "3701." Practically it is a six-coupled express bogie engine which has the four-wheeled bogie at the trailing instead of the leading end—as these terms are commonly understood. But in the present case one has to divest one's mind of these normal views of relative positions. For what would be the *trailing* end of the engine, according to the usual practice, is treated as the *leading* end in this instance. That is to say, the engine runs fire-box foremost and smoke-box behind, and the cab is closed in with a prow-shaped end containing six large windows. But, it will be asked, where does the engine carry her supplies of water and fuel? That is a question whose authoritative settlement must be postponed until a later article. For the present I must content myself with observing that coal bunkers of considerable size are fitted on both sides of the fire-box and foot-plate, while the smoke-box end of the engine—I cannot call it the "front" in these circumstances—is followed by a very long cylindrical tank mounted on a six-wheeler frame. In the rear of the tank is a second, but smaller, cab. The whole aspect of this vast but eccentric locomotive is such as to inspire puzzled amazement amounting almost to awe.

Another point which struck me as singular in connection with the locomotive exhibition was that an engine built by Messrs. Burnham,

Williams & Co., at the Baldwin Works, Philadelphia, for the Great Northern Railway of England—being in fact one of that series of goods locomotives to whose construction for the British service, and to the problems consequently suggested, I referred in three articles which appeared in THE ENGINEERING MAGAZINE last year*—is shown *in the British section* as an exhibit of the Great Northern Railway Company. This seems to me to be susceptible of misconception and somewhat misleading, but possibly there may have been reasons for the course which have not yet been pointed out to me. I illustrate the type. In this connection, it is noteworthy than the engine, "Koningin Wilhelmina," which was built by Messrs. Neilson, Reid & Co., of Glasgow, for the Dutch State Railway, and which I also now illustrate, is expressly shown as a British exhibit and not as a Dutch one. It would be interesting to know the reason for this difference of treatment.

One of the most remarkable locomotives in the entire Exhibition is the great four-cylinder compound, four-coupled, 10-wheeled express engine of the "Atlantic" type, No. 2642, designed by M. du Bousquet, the able ingénieur en chef du matériel et de la traction to the Chemin de Fer du Nord, on the de Glehn compound system, and built by the Société Alsacienne de Constructions Mécaniques, at Belfort. It is shown by the Nord company and the exhibitors have adopted the exceptional course of having two duplicate engines built, absolutely identical in every particular, the one being on show at Vincennes, while the other is exhibited to the public outside in actual work on the very fast expresses of the Nord line. This novel plan struck me as remarkably effective and impressive in view of the superb work accomplished by the running engine of the two sisters. Of that I shall have more to say subsequently.

I am indebted to M. de Glehn for the photograph from which my illustration of this engine is taken; to Messrs. Neilson, Reid & Co. for the photograph of the engine built by them for the Netherlands, and to Mr. F. Moore for the photographic originals of my other illustrations.

(To be continued.)

* Mr. Rous-Marten's widely-noticed articles on this subject appeared in the issues of THE ENGINEERING MAGAZINE for July, August, and September, 1899.

THE COMMERCIAL ORGANIZATION OF THE MACHINE-SHOP.

By Hugo Diemer.

IV.—THE PRODUCTION DEPARTMENT: THE EXECUTION OF THE WORK.

THERE are two considerations involved in the arrangement of machinery and shop departments in a factory building. The tools must be arranged so as to secure the least loss of power in transmission from the generating source, and both tools and departments must be arranged with due regard to facility and rapidity of handling of parts. As far as possible a piece or machine should travel, in its processes of manufacture, from one end of the shop toward the other. The most economical arrangement, so far as handling is concerned, is one in which the piece or machine has to be carried only short distances and in the same direction, instead of being carried to and fro from one end of a shop to the other in its various stages. An arrangement which would provide for the most economical handling, however, may not be the best from a standpoint of economic consumption of power. The factors of power efficiency and rapidity of handling are both continuous in their action, and how much one will outweigh the other depends in any individual case on the particular work done in that shop.

The final best arrangement is a matter which deserves careful mathematical calculation. This question, like many others, is apt to be decided in too off-hand a manner by a shop superintendent. It is certainly true that an experience of many years in shop work is a great aid in developing correct judgment in the deciding of this matter, as well as of the very important one of rates for piece-work or premiums; but accumulated data and mathematical calculations will frequently compel an experienced shop man to confess—sometimes very unwillingly—that he has committed errors in judgment by making an off-hand decision to which he has felt himself bound afterwards to adhere.

Prof. Diemer's papers began with the issue of THE ENGINEERING MAGAZINE for June, 1900. The preceding articles have been:

The Systematized Classification of Shop Orders.
The Production Department: Bills of Materia'.
The Production Department: Store-Room Management.

In very small machine shops it is not a difficult matter for the shop foreman to carry in his mind practically all the work he has to do on the orders he has in hand, but when the establishment has developed to a stage where perhaps a hundred hands are employed in the machine shop, assistance in the way of certain forms and clerical labor becomes not only an absolute necessity but a decided economy as well. Without such assistance, it is only a man of unusual capacity who will not find himself doing certain classes of machine work in two, three, or four lots, when a careful assortment of the orders in hand would have enabled him to do the same work consecutively, of course to much greater advantage.

While at first sight it might seem desirable to lay in a large stock of smaller parts of machines, irrespective of orders in hand, a more deliberate consideration will generally lead to the conclusion that it is unwise to provide more than a very limited excess of such parts over and above what is required for orders in hand. The reasons for this conclusion are two: First, the shop will be paying out money for labor and material which may not be converted into ready cash for some time to come. Second, minor changes in design are a certainty —which no one who is familiar with the constant evolution of machinery will deny—and in laying in a large stock of small parts a shop certainly exposes itself to the loss entailed by having on hand a considerable amount of material whose only value is its weight as scrap. Take a walk through the store-room of almost any large establishment, and ask the store-room boy "What is this?" and his answer will frequently be, "Oh, that's a lot of pieces that we used to use on our old style of machine. We don't use them now. Here is what we are using now," and he points out an equally large or larger stock of pieces of a different design, which the necessities of trade may require to be superseded at an early date. In certain classes of work it may be necessary to have on hand particular parts of old-style machines, delays in the replacing of which might cause sufficient loss to a customer to involve the loss of his patronage to the shop, but such particular parts are exceptions and what particular pieces they are the manufacturer knows best.

The "Sub-Order" system is a scheme devised primarily for the purpose of assorting all work in hand into the distinct operations involved. This separation forms a reliable basis for estimating the number of hours of work that any particular department or tool has ahead, and is a guide to accurate promises of delivery. It is *prima facie* evidence in considerations involving the addition or cutting off of labor,

or the purchase of new tools. The system may be briefly outlined as follows:

In addition to the general order or bill of material, each section is furnished by the shop office a set of "sub-orders" for each order. Each sub-order covers only the work that can be done by one tool or one class of workmen.

A practical form for the sub-order is as follows:

SECTION .....
SHOP ORDER.....
SUB-ORDER .....
DRAWING NO.....
PATTERN NO.....
Number of Pieces.....
Work to be done on Tools Nos.....
Operation .....
.....

Record of Time spent on above Sub-Order:

Date	Check No.	No. Hrs.	Date	Check No.	No. Hrs	Date	Check No.	No. Hrs.

Total Time spent on Order .... Hrs.

.....Perforated line.....

Section Foreman will tear off this slip and return to Shop Office. I estimate that the above operation will require.....Hrs.

Shop Order .....

Sub-Order.....

.....

Foreman Section.....

The sub-order is issued in triplicate from a stub-book consisting of two perforated and one unperforated sheet alternating so that one carbon copy remains in the book, while the original is issued to the sec-

tion foreman, and one carbon copy is sent to the time-keeping department. They are numbered as issued, beginning with No. 1 with the first sub-order issued under any one shop-order number.

The section foreman has a file board on which he keeps his sub-orders. He will usually find it most convenient to place next each other those sub-orders which cover similar operations.

The perforated slips at the bottom of the sub-order sheet are used to determine how much work is ahead. The foreman puts down his estimate of the number of hours required to do the work, and returns the slip at once to the shop office. A clerk in the time-keeping department keeps the estimates reported on these slips balanced up each day, so that a fairly accurate estimate of the total hours of work ahead for any department or any tool is always at hand. He should also check up the time actually spent on the sub-orders against these estimates, and report to the foreman any marked discrepancies. He needs to be strictly enjoined, however, that it is not his business to "call down" or criticise shop foremen for making errors in their estimates.

The general shop foreman should not be burdened with the task of writing out sub-orders. This work should be given to a competent man who need not be interrupted in his work. Usually a man fitted by previous training in the best possible way to fill the position of a clerk to issue sub-orders can be drawn from a class which is being developed in our larger manufacturing centers, and it is a class the developing of which needs the best encouragement that can be given by machine-shop managers. I refer to those boys and young men who enter machine shops as apprentices and who have sufficient ambition to study mechanical drawing. A course as an apprentice, followed by a period in the drafting room, will educate a clerk thoroughly competent to take hold of shop forms and data in an intelligent manner. Fresh college graduates, while frequently well-capacitated for such clerical work as this, are apt to consider the job as humiliating, and in consequence are not so likely to work the position to its fullest possibilities as a youth of the class to which I have referred may be expected to do.

The shop foreman must be among the men and tools and not at a desk. Over-burden your shop foreman with clerical labor, and a certain proportion of the mechanics will be governed by that unwritten machinist's law by the dictates of which he uses that cutting speed, feed, rake, and any other available method which does the least amount of work in the greatest amount of time. The fact that this unwritten law does exist is a most potent reason for appointing to the

position of shop foreman a man who has operated machine tools in person, with his own hands. A man may be a most excellent engineer and designer or manager, and still be totally unfit for the position of shop foreman.

The following office work is necessary to determine from the sub-orders a record of the cost of every operation on every piece that goes through the factory.

The cost or time-keeping department is furnished daily a carbon copy of every sub-order issued. The factory also furnishes daily a list of all sub-orders completed the previous day. Instead of a list, the foremen's copies themselves as completed may be turned in for this purpose.

The time-keeping department enters daily, on its carbon copy of sub-order, a record of the time, number of man, and rate for all labor on the sub-order. As soon as the sub-order has been announced complete, these entries are summed up and the results entered on a card index, the form of the card being as follows:

DRAWING NO. PATTERN NO. ARTICLE.

MATERIAL WEIGHT. COST OF MATERIAL.

Order No.	Sub-Order No.	Operation.	No. pcs.	No. of Man.	Time.		Rate.	Total Labor.	

The cards are filed consecutively according to drawing numbers. As there may be several different patterns shown on one drawing, there may be several cards bearing the same drawing number, the in-

dividual cards covering various patterns mentioned on the drawing in question. The operation and piece are easy to locate in the card cabinet by referring to the proper drawing number, as mentioned in the bill of material.

It will be at once apparent that a card record such as this affords a most reliable basis, not only for the cost of each operation, but for establishing piece-work and premium rates where such systems are in vogue in the shop.

I came into contact with the piece-work system the very first day that I entered a machine shop, and the impression as to its questionable efficacy made on me at that time has remained with me ever since. It was during a summer vacation while I was attending college. I had secured admission as an ordinary "hand" in a large manufacturing establishment in which piece-work was the general rule. Fired with the ambition of youth and the novelty of the work, I was working away with a will, when one of the men tapped me on the shoulder, and said: "See here, young fellow, you're working too fast. You'll spoil our job for us if you don't go slower."

It is unquestionably true that even in flourishing establishments, where the piece-work system has been in successful operation for years, the majority of the workmen are opposed to it. It is also true that they look with the utmost suspicion at the premium system, feeling that it is merely a lamb's skin to cover the same old wolf. I have seen an effort to introduce the premium system made with the best of intentions on the part of the management, with the only result that the majority of employees figured out how much more money the company had made than they had out of the scheme, or, as they put it, "out of how much the company had beat them." This simply illustrates the feeling which exists. What a campaign of education may accomplish in removing this prejudice remains to be seen.*

But without regard to the question of piece or premium rates, the card record above explained is a most reliable index to show which employees are the money-makers and which ones are the profit-de-

* A most significant instance of what may be accomplished by patient effort of the manager and reason on the part of the men is brought to our notice just as these pages are being closed. Mr. Norris, whose story of his well-thought-out attempt to introduce the premium system and of the bitter and seemingly ineradicable opposition of the organised labour in his works made so interesting a feature of our issues for January and February last, writes us as follows: "I know you will be interested to learn that I now have the premium plan under full swing in the shop—the last 'kicker' having accepted it last week. * * * A few men never ceased working under the plan since the date of its first introduction, one and one-half years ago. It was not until three months ago, however, that it came into anything like general use, and it is only two weeks since the last man to whom we can apply it has accepted it. * * * This man remarked: 'It is to the interest of machinists to keep

stroyers. One or two entries will not determine this, but several months' careful study will undoubtedly do so.

It is certain that a fluctuating income in itself is always disturbing to the peace of mind of a workman, and most piece-workers would be far better satisfied if their total annual income could be equally distributed. There are in any shop certain workmen who stand head and shoulders above the ordinary man in earning capacity, and the management can often well afford to pay such men higher than union wages. I have heard managers say that if they were to do this, every body else doing similar work would immediately ask for an increase. But the experiment has to my knowledge been successfully tried in at least one instance. An officer in an establishment which has been exceptionally successful in the manufacture of machine tools, and which handles a large foreign trade, attributes much of the success of the company to the fact that they have made an open practice of employing, at higher than union wages, men who have "graduated" from other machine shops. This establishment pays as high as $3.00 and $3.50 per day for first-class machinists, and as its business has increased there has been a constant influx of men to its ranks from a nearby etablishment whose mechanical and machine methods were well-nigh perfect, but who drew the line at $2.25 per day as the maximum salary they could afford to pay.

The practice of keeping account of the time taken by different workmen to do similar work is bound to have a good effect on shop discipline, and such data can be easily collected by the methods above suggested, in connection with the determination of accurate cost data, which latter are indispensable in a business of any magnitude.

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the time as high as possible, but if the premium plan is fair to one, it is fair for all.' He made $5.67 (premium) on the first job, saving over 43¾ hours over the best previous record."

This shop, it will be remembered, was the "leading case," referred to by Mr. O'Connell in our June issue—the one in which American trade-unionism would have finally and blindly crushed out the new and progressive systems of labour remuneration. The ultimate success of the premium plan in the Bickford works is of course far from being a solitary example, but it alone suffices to show that a single manufacturer, by patient persistence for a principle which is fair and sound and mutually advantageous, can finally overcome even the deepest-rooted predjudices of the unions. This and the recent settlement of the machinists' strike are hopeful signs of progress in the mechanical world.—THE EDITORS.

EDITORIAL COMMENT

A remarkable indication of the far-reaching influence of engineering science is seen in the manner in which the recent gatherings of engineers in London were received. Apart from the value of the papers and discussions, the social features showed the extent to which the engineer has taken his place in the fabric of society, upon which so many important relations depend.

The climax was reached in the visit to Windsor, when the extraordinary privileges granted the visiting engineers attracted much attention. The presentation of the officers of the engineering societies to the Queen was an honour which has rarely been given before, and must go far toward strengthening the ties already existing between both nations represented.

Much of the power which has been wielded by England during the reign of Queen Victoria has been due to the work of the engineer, and the recognition of this fact by the Queen is a noteworthy incident in the annals of the profession on both sides of the Atlantic.

There is a striking suggestion in this for the engineering profession, which is too apt to hold itself quite aloof from political matters, and, indeed, to be rather impatient of them. As a matter of fact, statecraft and handicraft are becoming more closely interwoven every day. The great undertakings which the engineer directs and the vast interests he represents are very dependent upon political administration at home and abroad, upon internal legislation and the conduct of foreign affairs. The essence of colonial expansion is industrial opportunity, not mere territorial addition. It will be well if engineers realise their position and influence, as those in control of the government recognise it, and learn to act promptly, decidedly, and unitedly in supporting or advising the government in matters touching the national welfare.

* * *

The vital connection between the price of iron and business activity, so ably argued by Mr. Hull in our August issue, is proven again by the stimulus to enquiry and the movement toward new undertakings which has sprung from the recent decline in the cost of iron and steel. The natural result is a manifest tendency toward renewed stiffening of prices, but there is no reason to anticipate any return to the extreme figures ruling some months ago. In fact, it seems justifiable to expect a gradual settling down to normal figures These will still leave abundant margin for profit to the furnaces and mills when accompanied, as they will be, by a corresponding movement toward sanity and reason among the sellers of ores and fuel.

The efforts to enlarge production under the pressure of the boom will certainly leave lasting effects in the direction of increased capacity, assuring fuller supplies of iron products in the future. In this enlargement of output the United States will have, no doubt, more than a proportionate share. The Carnegie works, which last year turned out 2,600,000 tons of steel —one-tenth of the world's product—is expected this year to deliver 3,400,000 tons, probably 13 per cent. of all the steel made in the world—more than half as much as the total output of Great Britain. The average rate of increase the world over is 12 per cent. per annum; the rate of increase of the Carnegie plant is about 25 per cent. per annum. It is the menace of this vast production, under conditions approaching the ideal in economy, which causes the apprehension among continental steel makers more fully touched upon on page 920 of this issue. There is no

doubt it means that British and German ironmasters must be content with lower prices, but there is no doubt either that they have a large margin of yet unrealised economies in manufacture which they will soon be forced to avail themselves of—all, eventually, to the advantage of the steel user. Cheap steel is the fundamental requirement of engineering activity and industrial prosperity. Cheap steel, wherever made, is at the command of buyers the world over. Cheapening of steel is in itself of so enormous advantage to enterprise of every character as to completely outbalance any local injury caused by the shifting of the centers of profitable steel-making.

* * *

The *Builder*, commenting upon Mr. James O'Connell's contribution in our June issue, says that his article, "if it refers to American workshops (it is not always easy to say whether an article in THE ENGINEERING MAGAZINE is American or English, unless specially stated), is quite at variance with the view given by the writer in the *Times*, referred to in a note on another page."

It is true that it is the peculiar province of THE ENGINEERING MAGAZINE to draw upon the leading thought and action of all the great industrial countries for its writers and its themes. The range of the magazine is as widely international as are important developments in engineering practice. But there need not be the slightest doubt as to the source of any particular article in its pages. It is strange that the *Builder's* reviewer could read Mr. O'Connell's paper sufficiently well to discover his views, and still remain in doubt whether he referred to English or American workshops.

He is introduced in the editorial preface to his article as "the official exponent of organised American labour." In the very first paragraph he hangs his whole argument upon the positions assumed by "the last convention of the International Association of Machinists, which was held in Buffalo, N. Y." Five times more he defines his views as those of the "International Association of Machinists," the distinctive American association corresponding to the British "Amalgamated Society of Engineers"; three times he expressly states that he speaks for "the average American machinist." And in the department of Authors and Papers, in the front of the magazine, his biography and career are given in full: Born at Minersville, Pa., apprenticed in American shops; associated since 1893 with the most characteristic of American labour unions.

THE ENGINEERING MAGAZINE invited Mr. O'Connell's contribution because, having frequently treated the question from the employer's standpoint, it believed genuine advantage would result if it (again quoting the editorial preface) "opened its pages to the leading exponent of American organised mechanical labour," and asked him "to join in the discussion and to define the attitude of the employee." The magazine made it very clear at the opening that it completely dissented from Mr. O'Connell's views; but where has the *Builder* been nodding, not to know a guest so clearly announced and so fully introduced?

* * *

Mr. Buel, in his interesting article on Porto Rico in our August number, ended his criticism of the 'Model and Training School" by felicitating the Porto Ricans upon the fact that at least it was not fireproof. The sheets of his article were hardly off the press when we received from him a newspaper clipping telling of the burning of the building. "No fire in my recollection," he says, "has been less lamentable. A disgrace to the American government has been destroyed. After General Meigs had finished the Pension Office in Washington, he asked Phil Sheridan what he thought of the criticisms passed on it. Sheridan said: 'Well, Meigs, the worst thing about it is, they tell me the damn thing is fireproof!' Let us thank the architect of the only Model and Training School that he did not make it fireproof."

REVIEW OF THE BRITISH PRESS

Combination and Competition.

MUCH has already been written about foreign competition and its consequences, and the subject bids fair to become rather wearisome, but since it is a very real factor in manufacturing and commercial affairs it should really be discussed from every practical point of view. A recent editorial in *Engineering* takes up the relation which trade combinations bear to this question, considering very thoughtfully the influence of the combinations so much in vogue in the United States, and comparing with these some which have been formed in Great Britain. The foundation of successful competition is the reduction in cost of the product, character and quality remaining unchanged. Formerly the prime element of cost was the wages of the man by whom the article was made. With the introduction of machinery the product was cheapened in this respect, until the item of so-called "general" expense has become equally important, if not more so. The labour cost of an article has been diminished, not by reducing the pay of the workman, but by increasing his output.

The general expense per unit of product is naturally diminished with the increased output, since the total expenditure is divided among a greater number of units, but this method alone will not suffice to reduce this element of cost, and hence the next step has been to reduce the total amount of general expense by combining a number of manufacturing establishments under one management. This enables expenses of supervision and direction to be greatly reduced, and at the same time aids to improve the product.

Taking a large product, such for example as a ship-of-war, and it is evident that the union in one firm of the divers manufactures which are required in its construction lessens not only the charges of supervision, but also results in a reduction in the time-cost of the work, especially where all the contributory establishments are under a common direction, working in unison.

"Under the conditions still generally obtaining in Great Britain there are between the raw material and the ship the iron ore miner, the coal miner, the ship owner carrying the coal, ore and other materials, the iron master, the steel maker, and probably the iron founder, forger and marine engine builder, each involving separate and avoidable charges, as well as profit.

"Under the new conditions, which are aimed at by the combinations which have been perfected, or are in contemplation, there would be far fewer intermediaries between the raw material and the finished product ready for its carrying trade."

Although such a combination eliminates, to a certain extent, the competition between those who supply the material, this fact does not tend to increase the price, since the price is mainly governed by the final competition. The element of competition is not reduced when the steelmaker joins forces with the shipbuilder.

"If a shipowner who wants a ship can get two or three builders to tender he is not concerned where the steel and iron come from. What he is chiefly interested in, next to cheapness in cost, is quick, or, at any rate, certain delivery, and unity of purpose on the part of those concerned in the various parts of construction and fittings. Work carried out by a crowd of contractors, who have no common interest, can never be so well done as when the whole is executed by a single firm, and, although it may not be possible to point to faults that call for remedy, yet there is departure from that standard which merits the definition first-class."

That the truth of these facts is being appreciated in Great Britain is demonstrated by the steady increase in the number of combinations and amalgamations effected during the past few years, and by the indications that many others will probably

follow. Space will not permit the enumeration at this time, nor is it necessary; it is the principle which is sought to be established.

There is another feature in connection with such combinations which should be considered; the ability of strong combinations of capital to effect the employment of methods which would be impossible on a smaller scale.

"The competition of American and other foreign countries in the manufacture of iron and steel goods makes it incumbent upon British manufacturers that they should effect all the economies and improvements possible in order to meet these rivals; and in the way of economies there is everything to be said for the control of a big company of its main sources of supply. All the leading American establishments do this, and much of their success is, no doubt, due to their foresight in acquiring and developing iron-bearing ground when it was cheap."

The extent to which such industrial combinations may develop into the still greater combinations, called in America "trusts," is a matter which cannot be considered here, and in any case the objections which may properly be made against them do not impair the strength of the contention that combinations enable a better product to be made at a greatly reduced cost and in far less time than by the old methods.

Power-Station Design.

A PAPER presented by Mr. Philip Dawson before the Tramways and Light Railways Association during the recent exhibition, and published in the *Electrical Review*, contains some useful and extremely practical points about the general conditions governing traction power station design.

In the first place, it is pointed out that a low cost per unit of electrical energy at the switchboard does not necessarily mean a low cost per car or per train-mile, as it is possible that, in order to secure cheap current, the power station may be so located as to cause great expense in feeders, sub-stations, and loss in transmission. While this applies both to traction and to lighting, the demand for current for both purposes is increasing so rapidly that lighting is becoming a secondary consideration.

Comparing the differences between lighting stations and those designed for power only, a number of interesting points are made.

"The average number of hours per annum during which a lighting station will be running full load will probably never be equivalent to more than three months' continuous running per annum, that is to say, taking the total Board of Trade units generated in one year, and seeing how long the plant under consideration would have to run its full capacity continuously to generate this amount, this time would probably never exceed three months. Taking a representative traction station, the time of continuous running would probably be at least 9, and in some cases 10, and even 11 months.

A lighting plant must in three months earn enough money to pay working expenses and to pay interest and allow for depreciation and sinking fund for a whole year, whereas a traction plant has from 9 to 11 months to do the same thing.

"A lighting plant is on an average practically at a standstill 18 hours a day, while a traction plant is running 18 to 20 hours a day. Economical boilers, engines and electrical generating and transmission devices are therefore far more important in a traction than a lighting plant, because it is well known that running at very light loads and keeping the fires banked and the boilers, steam pipes, engines, etc., hot, uses very nearly as much fuel as running them at full load.

"Furthermore, whereas in a lighting plant there is ample time to overhaul the plant and execute necessary repairs, the men during the day have little or nothing to do and can well do this work. In a traction plant there is little or no time to do this. The conditions are quite, if not more, arduous than on a ship. There at least every few days or few weeks the whole plant is entirely shut down for several days and can be taken to pieces and overhauled.

"Unexpected and rapid overloads must be able to be supported by the traction plant, which is not generally the case in lighting.

"In a traction station it will be seen that a far greater figure is cut by the cost of generation, pure and simple, than in a light-

ing station, and that the question of interest on capital expenditure and sinking fund is relatively smaller in the former than in the latter."

Tabulating the figures, which are deduced from actual practice, Mr. Dawson shows that the cost of power when generated for power and traction purposes is only about one-quarter of that when generated for lighting purposes.

The economies to be effected by judicious arrangement of distribution are discussed at length, and, compared with the system of feeders, distributers, track, and overhead line, the cost of the power-station is a comparatively small item. The saving which can be effected by a properly designed station is very great, and a little extra expenditure is in many instances well justified.

The advantages in the use of polyphase currents are shown to be great, and Mr. Dawson advises for anything above 5,000 kw. capacity, one polyphase station, operating rotary-converter sub-stations.

"All engine builders who have had experience in tramway work now make an entirely different kind of engine for traction from that which they supply for lighting stations. The conditions under which a tramway engine works are, if anything, more onerous than those of a rolling-mill engine. A slight variation, either in number of revolutions per minute, or in angular velocity per revolution, is of the greatest importance in a traction station, whereas it is of small importance in a rolling mill.

"A uniform speed is especially important where compound wound dynamos are run in parallel direct on to the line. If the momentary difference in speed between two engines exceeds very narrow limits, the voltages of the machines differ, and cause very heavy currents in the equalising bars, and largely increased core losses, hence great waste. If the difference becomes too great, one of the generators may even be reversed. Where polyphase machines run in parallel, constant speed is of even greater importance to keep the machines in step. In cases where shunt wound generators with heavy batteries of accumulators run in parallel on the line, the question of engine regulation is not so important.

"A traction station where compound wound dynamos are used should be so arranged that, if the normal load be suddenly thrown on or off an engine, the speed shall not vary more than 2 per cent. either way. In some cases a maximum variation of 1½ and 1¼ per cent. is all that is allowed. Where polyphase currents are used, constant speed is of even greater importance, and a guarantee should be required that under no circumstances shall the angular velocity during one revolution vary more than ½ (1½?) per cent., and in some cases not more than half of 1 per cent. With heavy flywheels, and governors properly designed for tramway work, it is quite practicable to fulfill the above conditions."

Recent Locomotive Practice in France.

THE paper of M. Edouard Sauvage, recently presented before the Institution of Mechanical Engineers, upon the developments in locomotive engineering in France, contains much that is valuable and instructive. The increase in power of the locomotives on the French railways is a matter which has been observed by engineers of other countries already, but a detailed account of the development by one so well adapted to give accurate information as is M. Sauvage, is especially worthy of notice.

The feature which makes the first impression upon the reader of the paper is the large number of compound locomotives in use in France; indeed, the paper might almost be entitled "compound locomotives in France," there being more than 800 four-cylinder compound engines in service or under construction. These locomotives vary somewhat in design, according to the railways on which they are used and the service for which they are intended. "The four cylinders drive either two, three, or four axles. With two driving axles the machines have large wheels, and are intended specially for working express trains, but they may also be employed advantageously for the heaviest passenger trains, and even in certain cases for goods trains. The locomotives with three axles have also large wheels. They draw easily long goods trains or heavy passenger trains; they have been employed to work express trains, but exceptionally rather than regularly. This type of engine renders very great service, since it is suitable for almost all trains; it al-

lows considerable increase in speed for goods trains, which becomes more and more necessary on the network of the principal French lines."

M. Sauvage gives in his paper a number of schematic illustrations, showing the development of the compound locomotive in France since 1885, with a tabulated list of the four cylinder compounds in use or on order on January 1, 1900; the total foots up 803, and does not include Mallet two-cylinder locomotives used on light railways of the metre gauge.

Careful comparisons of these compound locomotives with equivalent two-cylinder engines have shown that the fuel economy attained by a use of the compound engines is at least 12 per cent. In making these comparisons every care was taken to put the engines to various duties, to employ exactly the same kind of fuel in all cases, and to change the men often. Although this is not so high an economy as has been claimed elsewhere for compound locomotives, yet it is the result of very careful investigation, under operative conditions, and is probably within the figures which would be obtained by special tests.

In general arrangement the plan of construction which has found favour in France, is that with the low-pressure cylinders inside, connected to the forward cranked axle, the high-pressure cylinders being outside and connected to the same axle. Side rods are used to drive the rear axle, and a bogie is used forward. For the valve gear the Walschaert is used outside, and either the Walschaert or the Gooch inside. There are two lifting shafts arranged to be operated separately, or connected in any desired relation, so that almost any desired steam distribution can be obtained.

For starting, high-pressure steam is admitted into the receiver, and in addition a relief valve is provided for the exhaust of the high-pressure cylinders, so that, if necessary, the engine can be converted into a simple four-cylinder engine.

Belpaire fire-boxes are generally employed and ribbed tubes are frequently used. Experience has shown that ribbed tubes are just as serviceable as ordinary tubes having the same internal surface in contact with the hot gases. A deposit of coke sometimes forms between the ribs, but this is removed from time to time. Steam pressures are carried as high as 200 to 228 pounds per square inch, in order to permit the full benefit of compounding to be attained. M. Sauvage's paper gives many useful details in regard to the construction and operation of these locomotives, and from its extremely practical nature it must be regarded as a very valuable contribution to railway literature. This is especially the case in view of the advance in service which has been made of late on the principal railways of France, and there is little doubt that much of the success which has there been attained with heavy high-speed trains is due to the improved powerful compound locomotives employed. Compounding is certainly an assured fact, and while there may be differences of opinion as to minor details, the general arrangement of the principal engines described by M. Sauvage appears to be the most successful yet employed.

Cheap Power.

In view of the increasing cost of fuel, upon which by far the greater part of our prime movers depend as their source of energy, a recent editorial in *The Engineer* is timely. Other countries have in many cases available water power, but in England coal is the prime source of power, and the increased value of coal brings into unusual prominence schemes for obtaining the largest possible quantity of power out of the smallest possible quantity of fuel.

It is admitted that there are other available sources—the wind, water, and the sea—but methods for using these, in England at least, have not been reduced to the practical stage.

Coming back, then, to coal, the question at present appears to be the best method of obtaining the highest efficiency by its combustion and conversion into power, and at the present time attention is strongly directed toward internal combustion motors, or, as they are more commonly called, gas engines.

Formerly these were limited to small powers, but of late the capacity has continually increased, until we have at the Paris Exposition the great Cockerill blowing engine, giving 1,000 h.p. with illuminating gas, or about 700 h.p. with lean blast-furnace gas. The fact that orders have

been taken for more than 70 of these engines is evidence of the interest which is taken in this subject, while on all sides we see the makers of gas engines increasing the capacity of their products. Where blast-furnace gas is not available, producer gas may readily be substituted.

"It is not to be supposed that those who have steam engines now will reject them in favour of gas engines; nor is it desirable that they should attempt it. The whole cost of power is made up of many items, and it does not necessarily follow that because a gas engine plant uses less coal per horse-power per hour than a steam engine plant, that it is, therefore, the most economical all 'round. Various factors come into operation and modify the result for good or evil; but when the substitution of gas for steam is out of the question, the millowner ought not to sit down and assume that his engines and boilers do not admit of being improved. The augmented price of coal should lead to a complete overhaul of plant. We can do no more than hint at certain things that may be done with advantage. Boilers should be carefully scaled and kept clean. Great quantities of heat are wasted when furnaces and flues are covered thickly with non-conducting scale. Valves and pistons should be overhauled, and certainty obtained that they are not leaking. Tight valves and pistons are the exception rather than the rule. Many engines are running with far too much clearance. The reduction of this will be found remunerative. It may be done by bolting plates to the piston faces, or by turning so much off the cylinder cover flanges as will let the covers further into the cylinders. Reduction of clearance often effects an economy so considerable that it is next to impossible to account for it. But the most ready method in a large number of cases of saving fuel lies in improving the vacuum, or, more exactly, in reducing the back pressure in the low-pressure cylinders. The importance of this is curiously overlooked. Let us take an engine with a low-pressure cylinder 55 in. diameter, and a piston speed of 600 ft. per minute, then 1 lb. per square inch effective pressure represents 43 horse-power. The total power of such an engine, assuming it to be compound, would probably be 800 indicated horse-power. One pound of back pressure represents 5 per cent. Certainly over 40 horse-power is worth having, if, as is often the case, it can be had for nothing."

The Prevention of Water Waste.

THE question of the waste of water is one which has been constantly growing in importance in many great cities, and especially when the introduction of filtration plants is considered does it come up most urgently for consideration.

In a paper presented before the British Association of Waterworks Engineers, at their Cardiff meeting, by M. A. J. Jenkins, this subject was treated mainly to show the relationship between the cost of the water wasted and the cost of prevention and detection of waste, a relation of prime importance from the commercial viewpoint.

Water wastes may be classified under three heads: those due to overdrawing and leaving taps running after use; those due to defects in mains and service pipes, and those due to the use of inferior taps of all kinds and to siphon cisterns.

The first class of wastes are mainly due to carelessness and to an idea among many people that the supply is unlimited. The only remedy for it appears to be the introduction of house meters.

Defects in mains and service pipes are great sources of waste, and being hidden from sight, are not always soon discovered. Mains are sometimes broken through local circumstances, and unless the character of the ground is such that the leaks quickly show themselves at the surface or in the sewers, these are usually first detected through the falling pressure. The increasing use of asphalt or wood paving, upon a bed of impervious concrete, tends to prevent, to a very marked extent, the appearance of leaks at the road surface. By the use of self-registering district meters any increased flow of water during the small hours of the morning becomes an indication of leakage, and acts as a check upon the reports of turncocks, who should be continually examining the pressure in all parts of their districts.

A very fruitful source of waste is found in inferior fittings. This is only partially mitigated by a system of control, any examination of new fittings being necessarily

superficial, and unsatisfactory. The free renewal of washers of leaky taps is a plan which has proved very economical, the annual cost not exceeding 2d. per tap, this being far less than the value of the water wasted, since consumers are usually most dilatory in the matter of making repairs of this character.

By the employment of a competent staff of waste inspectors, with a periodical system of house to house inspection, waste may be very greatly reduced. This should be supplemented by district registering meters, above referred to, and a careful use of the stethoscope applied to the outside stop taps. Meters should be periodically examined and tested. Moderately-worked meters remain accurate the longest, but idleness is more harmful than overwork. The annual cost of examining meters at Cardiff has been found to be materially within the saving effected by such testing.

"The necessity for the husbanding of supplies must become more pressing every year; the requirements of sanitation naturally lead to an increased domestic consumption, the requirements of trade are upon the increase, and the growth of populations in the larger towns is progressing at an enormous rate; it is true there are still large areas of gathering grounds unappropriated, but for the most part at great distances from large towns; each year the cost of works is increasing, and if economies can be made in existing supplies and the increased demands be partially, if not wholly, met by the prevention of waste, then it behooves water authorities to make those economies."

The following conclusions are submitted as a summary:

"1. That to keep the supply of a district within reasonable bounds, an efficient system of inspection is necessary.

"2. That a regular and systematic inspection can be carried on at a very reasonable cost, which will certainly be repaid in the value of the water saved.

"3. That the prevention of waste will be facilitated by the introduction of a system of testing and stamping of all fittings.

"4. That within certain limits the expenditure incurred by the execution of 'free repairs' is warranted by the saving of water resulting."

Electric-Power Distribution in Great Britain.

As a result of the inquiry of the Select Committee of the House of Commons into the merits of certain bills submitted for supplying electric energy over extended areas, the question of electric power distribution has been materially cleared up. It has long been admitted that the principal impediment to the rapid extension of the use of electric power has been the dilatory action of the local authorities, who would neither install plants themselves nor permit others to do so. It has also been admitted that there are no insuperable difficulties connected with the generation of electricity and its distribution, from an engineering point of view, and, indeed, in view of the many and large installations in successful operation on the Continent and in America, it certainly seems needless to go into any especial argument upon this point. Notwithstanding the existence of the numerous large plants in Germany, Switzerland and France, as well as the great installations at Niagara and elsewhere, it was only two years ago that a Joint Committee arrived at the conclusion that it was unnecessary to hear engineering evidence to the effect that such schemes were practicable. It was then also admitted to be clear that it was a matter of importance to manufacturers that they should be able to obtain cheap electric power from central sources, so that these elementary questions no longer remained to consume time, while Britain's competitors were busily constructing and operating their works. The hearing at the present time has therefore been devoted mainly to an examination of the desirability of the schemes proposed, and to the treatment of the opposition of local authorities.

A summary of the hearing in a recent issue of *The Engineer* gives a clear account of the result of the inquiry, and an abstract is here given:

The bills under consideration include five plans, providing for electric power supply in Tyne district, in the manufacturing districts of Lancashire, in South Wales, and on the Shannon. In all cases the local authorities have entered opposition, this opposition being based upon questions of interference with roads, about which they are always ready to make a terrible outcry, and

of possible competition with their own undertakings. The nervousness about competition with local undertakings is most instructive, since it clearly admits that they realise that their own high prices for electric energy cannot stand in the face of such competition, and can be construed into nothing else than a desire to maintain monopoly in order that such prices may be upheld. The short-sightedness of such a position is evident when it is seen that the whole district must suffer from foreign competition if local competition is not permitted full scope; and in this respect the evidence before the committee dealt with foreign competition, and the relative progress of other countries in regard to the use of electricity. The most important testimony in this respect was that of Mr. Arthur Keen, well known in connection with the amalgamation of the Patent Nut and Bolt Company with the Dowlais works, and other large manufacturing interests in South Wales and elsewhere. Mr. Keen spoke of the disadvantages experienced under present conditions, citing the fact that steel makers in America can get their coal at 4s. per ton and ore at 5s., while the cost of the coal used by them in South Wales is 16s. per ton, and ore 15s. to 20s. per ton. While these figures are impressive they do not bear directly upon the question of the distribution of electricity, but they do show the necessity of doing everything possible to favour cheapness in other directions, in order to assist in equalising this great difference. Describing his observations during recent visits to the United States, Canada and Germany, he related how he found power supplied from central stations, sometimes thirty-five miles away, and showed the great advantage resulting from such a concentration of operation.

The question of local opposition is very clearly seen to be a desire to prevent competition, but this really comes back to a consideration of the fundamental interests of the districts under consideration. To the disinterested observer it seems supremely ridiculous to waste months of precious time gravely discussing questions long ago settled in other parts of the world beyond controversy, permitting valuable trade to be captured by rival nations, not only without effort, but really with positive assistance. Britain's industries are daily being invaded by Germany, Belgium, America, while parliamentary committees are wrestling with local authorities as to "how not to do it."

The present position of the matter, so far as the above mentioned bills are concerned, is announced by the committee in the following paragraph:

"A local authority which undertakes, and is prepared to give, a full and ample supply of electrical energy for all purposes to consumers within its district ought not, without its consent, to be required to give facilities for the supply within its district of electrical energy by other undertakers. But if a local authority is unable or unwilling to provide, on reasonable terms and within a reasonable time, a full and adequate supply of electrical energy for any purposes to any company or person applying for the same within its district, such company or person should be at liberty, after notice to the local authority, to obtain their supply from other authorised undertakers, and the local authority should be required to give all necessary facilities for this purpose. Any difference arising out of the above questions should be the subject of arbitration, as provided by the general Acts."

This leaves the situation in such a shape as to cause it almost certain that in each case interminable discussions will follow as to what constitute reasonable terms and what is a reasonable time. While apparently placing the matter in a definite position, the clause above quoted really makes further delay inevitable. It is hardly to be expected that the municipalities will throw themselves into this question of power supply with the energy which it demands; nor, in view of past experience, is it likely that they will be willing to concede the privileges to private undertakers.

Is it not more likely that, when they can do nothing, or do not wish to proceed, they will delay and equivocate as they have done in the past, and that under such a state of things as the committee's clause foreshadows, progress, whether on the part of the municipalities or of private enterprise, will, relatively to the progress in other countries, be very slow, and be attended with much expense, uncertainty, and difficulty?

The Properties of Lubricants.

EXPERIENCE with various kinds of lubricants, especially since the introduction of modern mineral oils, has shown that something more than the mere statement of specific gravity is necessary in order to determine the lubricating value. A recent paper in *The Engineer*, upon the "oiliness" of lubricating oils, discusses the properties upon which the lubricating value of oils depend, and shows the importance of a careful investigation of an oil for any especial service.

After it was understood that specific gravity was not the sole criterion of lubricating value, viscosity became the gauge, and it was held that the best oil was one which possessed the lowest viscosity compatible with a power of keeping the moving surfaces from touching one another, under the conditions of temperature, load, and area obtaining in the bearing to which the load had to be applied.

The relation between viscosity and lubricating power has been observed for about twenty years, and the lubricating power was at first supposed to be inversely proportional to its viscosity. Of late, however, it has been realized that viscosity is not the true measure of lubricating value, and that it rather depends upon another property, which, for lack of a better name, has been termed "oiliness." With high speeds, moderate loads, and good lubrication, it is no doubt the degree of fluidity which principally determines the value of a lubricant for any particular purpose, but when the speeds are slow or very high, the loads great, or the lubrication imperfect, "oiliness" plays the most important part in the reduction of frictional resistances.

The question of temperature enters into the matter as an important factor. Viscosity falls as temperature rises, and the fall is much more rapid among mineral oils than among such as are derived from vegetable and animal sources. Very moderate changes in temperature, due either to the weather, or to the revolution of the lubricated spindle, may be too small to affect the viscosity of a fatty oil and yet large enough to lower the viscosity of a mineral oil, and render it too thin to carry the load.

A good example of the difference between viscosity and oiliness is given from the treatise of Archbutt and Deeley by comparing glycerine and sperm oil. Glycerine is undoubtedly more viscid than sperm oil, and yet the latter feels smooth and greasy when rubbed between the fingers, while glycerine feels harsh. It is hardly fair, however, to consider glycerine as an oil at all, and the speed at which it loses its viscosity with rising temperature does not appear to have been investigated. Many liquids are viscid that have not the least claim to oiliness, and this shows that oiliness is not the same thing as viscosity.

The fundamental idea underlying lubrication is the avoidance of solid friction, and hence one of the important properties of a lubricant is that which prevents it from being driven out when the bearing is subjected to pressure. The extent to which this requirement is met by viscosity alone is questionable. Viscosity, or "body," as it has been termed, is really a sluggishness, due to a sort of internal friction, which causes the lubricant to delay the action of forces tending to press it out of a bearing, but which cannot be expected to exert a final effort. The film of lubricant might ultimately be forced out, were it not for the fact that adhesiveness and capillary action enter to retain sufficient lubricant to prevent metallic contact.

In this connection it is important that adhesiveness be clearly understood as different from what is termed "tackiness" in an ink or a varnish, and that it is really what is known as cohesion. What is really desired is the property called "body," which carries with it the cohesion which, acting with capillarity, gives to a lubricant the power of remaining between two surfaces subjected to pressure.

This whole subject is one which can only be considered broadly unless a specific instance is taken, but when the conditions of area, temperature, pressure, and speed are given, may be examined in detail. It is manifestly impossible to indicate the comparative value of various lubricants unless the conditions under which they are to operate are fully known. Knowing the operative conditions, however, it is practicable to select the best lubricant for the purpose, thus enabling the maximum reduction in frictional resistance to be secured at a minimum cost.

Chinese Mining Concessions to Foreigners.

AT this time, when the attention of the world is fixed on China, it may be of interest to glance at a list of some of the concessions for mining in that country which were granted to foreigners before the outbreak of the present troubles. According to Herr Paul Speier, who writes in a recent issue of *Glückauf*, the principal concessions were the following:

1. That to the Peking Syndicate—an English company—for coal and iron mining in the provinces of Shansi and Hunan. The company agreed to pay 5 per cent. of the gross earnings to the Chinese government, and also 25 per cent. of that part of the net earnings remaining after providing for a 6 per cent. dividend to the stockholders, and for an annual sinking fund payment amounting to 10 per cent. of the capital. The concession covers enormous beds of anthracite coal, but in the two years since the grant was made, nothing has been done to develop the property except the geological surveying work of the engineering staff.

2. A German company has been granted a provisional concession for mining in four districts of Shan Tung, where the principal mineral wealth consists of coal.

3. The Manchu governor in Urga, North Mongolia, was appointed director of mines for a large territory which stretches along the Siberian border, and the mining rights there were granted to a Russian who had been an official of the Chinese government. A Russo-French company was formed with a capital of 3,000,000 rubles, a staff of American engineers was engaged and the work is in full operation—or was before the recent troubles began. Gold is said to be the principal product, of which 30 per cent. is paid to the Chinese government and 20 per cent. to the Mongolian magistrates.

4. A concession has been granted to a French company for obtaining quicksilver in the province of Kwaichau.

5. Another French company has obtained mining rights in some districts of Sze-Chuen. The conditions are unknown, but the work has begun.

6. Still another mining concession has been given to a French company in several districts of Yunan, the conditions attached to which are not known.

7. The Chinese Eastern Railway, a Russian enterprise, has mining rights for a distance of five miles on either side of its line.

8. Similar privileges have been granted to the Hankow-Canton Railway, an American undertaking.

Besides these strictly foreign concessions may be mentioned a couple of mining enterprises in which the capital is Chinese, but the engineering management is foreign. Such a condition exists in the province of Chi-li, where the viceroy, Chang Yen Mow, began mining on a systematic plan with the assistance of Herr Georg Detring, who, as commissioner of indirect taxes, has been a constant adviser of the Chinese government. A staff of ten engineers has been occupied in preliminary surveying and practical mining operations, and the capital for the undertaking has been exclusively Chinese. At thirty or forty places in the province, gold, silver and coal mines are worked by modern methods. This mining organisation, the only really profitable one, has a yearly product amounting to 800,000 taels, thanks to the activity of Herr Detring.

In the province of Sze-Chuen, Li Tai Ching, as director of a similar syndicate, has begun negotiations with an Anglo-Belgian company, and it appears likely that in the future the Chinese will enter into business relations with foreigners on the basis of this system.

American Competition in Germany.

A GREAT deal has been said and written about American competition in engineering work abroad, and the subject has been pretty thoroughly discussed, in so far as it

relates to England, in a notable series of articles in *Engineering*. But it is of never-failing interest to try to "see ourselves as others see us," and so it may not be amiss to make a few extracts from an address by Herr Unger before the Verein Deutscher Maschinen-Ingenieure, as reported in a recent issue of *Glaser's Annalen*.

The address is entitled "Has the German Machine Industry Anything to Learn from the American?" and after mentioning some of the British experience with American competition, the author goes on to speak particularly of the superiority of American machine tools and the causes therefor.

Statistics show that the importation of American machines into Germany is continually increasing, and if the newest and largest factories about Berlin are inspected, it is found that they are very well provided with American machine tools, this being notably the case at the Ludwig Loewe establishment, the Borsig engine works, the Allgemeine Elektricitäts Gesellschaft's plant, and in other places. Many business houses are occupied solely, and very successfully, with the sale of American machines. Now if all this is possible when German mechanical engineering is doing its utmost, the superiority of the Americans in several lines, particularly in machine tools, must be evident, and the question contained in the title of the address becomes very pertinent.

It is self evident that foreign products will find a sale only when they are cheaper than the domestic, or when they better fulfil the purposes for which they are intended.

It is hard to understand, off hand, how it is possible for America to manufacture so cheaply that its machines can compete successfully in Germany with those made there. The circumstance that the American manufacturer, protected by a very high tariff, makes such big profits at home that he is able to sell at lower prices abroad, does not offer a sufficient explanation. The lower cost of material at the place of production in America is also not decisive, for the American must either bring the raw material from a great distance to his factory, or must transport the finished product a long way to the coast. The ocean must then be crossed and the German duties paid, so that the transportation charges on the smaller and medium-sized American machines amount to 8 or 10 per cent. of their value, and to even more on large machines. Moreover, the wages in America are higher than in any other country. When, in spite of all these difficulties, American machines undersell the German, there can be only one explanation, which is that the Americans work with better and more perfect methods than do the Germans, methods by which the cost of production is reduced to the lowest point. If Germany wishes to retain its mechanical industries, it must learn those methods.

Herr Unger then reviews some of the points in American methods. He finds that automatic machinery is very highly developed in America. One workman can often tend half a dozen machines. While this saves an enormous labour cost on one hand, on the other it assures to the really able workman such high wages as are not dreamed of in Germany. The prospect of high wages, and the further prospect of winning his way to a leading position in a short time, excites the ambition of the American workman, whether he be a native or a foreigner, and he devotes all his brains and energy to improving and simplifying his methods of production. In this he is encouraged by his employer, who is always ready to discard antiquated methods and machines in favor of better ones. Wherever it is feasible, machines are used instead of hand work, and this is done to an extent which seems strange to a German.

A machine is used for only one kind of work, and, if possible, for a single purpose. It turns out a special product in great quantities. This specialisation and production in quantity form the basis of the extraordinary efficiency of American factories and their competitive strength when opposed to Old World methods.

In America some of the largest and most completely equipped works produce only two or three kinds of machines, and sometimes only one kind, and seldom have their own foundry, as this is looked upon as another specialty. In Germany, on the contrary, the medium-sized and smaller works take particular pride in "making everything."

The American manufacturer is far more

favourably situated. He is complete master of his comparatively narrow field; he is thoroughly up-to-date, and so does not allow himself to be dictated to by his customers. His machines are standardised and a stock is kept on hand, so that orders can be immediately filled. Production is systematised and there is a thorough division of labour. Each tool performs a definite operation, and then passes the piece on to the next tool. The parts are submitted to a rigid inspection as they pass from tool to tool, so that at last, when they are assembled, there are almost no corrections to be made.

These are the general reasons for the cheapness of American machines. That they are also of good and suitable construction is natural from the specialisation and sharp competition in America, and is evidenced by their employment in some of the leading German establishments, where mere cheapness would not win a way for them.

Herr Unger believes that the Germans will have to adopt American methods and tools of American pattern in order to compete successfully with Americans, and he gives various examples of this tendency in German mechanical industries.

Test of a Parsons Steam Turbine.

We are accustomed to associate Parsons steam turbines with high-speed torpedo boats, and to pay comparatively little regard to their activity in other fields; but some recent tests of a turbine designed to drive a 1,000-kilowatt rotary-current dynamo compel more than passing attention. This turbine is one of a pair ordered by the city of Elberfeld for its new central station, and combined with a rotary-current machine, an exciting dynamo, a condenser, and air-pump apparatus forms a generating unit.

At a speed of 1,500 revolutions per minute, at 4,000 volts and 50 periods per second, the dynamo is to deliver 1,000 kilowatts when the cosine of the angle measuring the difference in phase between electromotive force and current is 0.8. The turbine contains two groups of guide blades and wheel blades, the first group high-pressure and the second low-pressure, through which the steam passes in turn. The air pump is run by worm gearing at one-eighth the speed of the turbine. The dynamo is directly coupled to the turbine, and carries the exciting-current machine on the outer end of its shaft.

Before these machines were accepted by Elberfeld, a very thorough test of one of the sets of machines was made on behalf of the city by three experts—W. H. Lindlay and Professors M. Schröter and H. F. Weber. The turbine and dynamo, with all the auxiliary machinery and connections, were erected at the Parsons works, and tests under various conditions and with different loads were carried out with elaborate precautions. The inductionless load consisted of a water resistance in four iron tanks, each corresponding to one-quarter of the load. The bottom and sides of each tank formed one electrode, while the other dipped into the water and could be raised and lowered, thus varying the resistance, so that the load could be easily adjusted. The inductive resistance, when used, consisted of a large coil, the interior of which was partly filled with iron plates whose amount could be varied until the desired difference of phase was obtained.

The results of the tests are given in full by the *Zeitschrift des Vereines Deutscher Ingenieure*, from which some figures are here abstracted. The first series of experiments was made to determine the steam consumption under different loads. As the steam pressure and the degree of superheating varied during the tests, the amount of steam per kilowatt-hour was calculated from the observed results for an average pressure of 11 atmospheres, absolute (162 pounds per square inch), and 14.3 degrees of superheating, with the following results:

Dynamo load in kilowatts		Pounds of steam per kilowatt-hour
1190.1	(overload)	19.3
994.8	(full load)	20.1
745.3	(¾ load)	22.2
498.7	(½ load)	25.4
246.5	(¼ load)	33.8

When running with no load, with the field magnets of the dynamo excited, the turbine used 4,057 pounds of steam per hour; and when the field magnets were not excited, the consumption of steam was 2,604 pounds per hour.

The steam consumption for loads of one-half the normal and upwards more than

satisfied the contract requirements, and though the figures for one-quarter load and no load were not quite so good, this is partly accounted for by the fact that the contract specified steam with 50 degrees of superheating, while that actually used in the tests was superheated, on the average, only 14.3 degrees. At any rate, any possible deficiency at the very light loads is more than made up by the excess at the heavier ones, particularly as the turbine will generally be run with high loads, and very seldom with less than one-third of the normal, and the results of the tests as to the useful work done and steam consumed may be regarded as eminently satisfactory.

The turbine itself, at a steam pressure of 11 atmospheres, absolute, delivered from 1,300 to 1,400 kilowatts (1,740 to 1,870 horse-power).

The contract specified that with a gradual change from no load to full load and vice versa, the speed should not vary more than 4 per cent. The variation determined by experiment was only 3.6 per cent.

With sudden changes of 25 per cent. in the load, the centrifugal governor was to hold the speed variation within 0.8 per cent. In the tests the loads underwent sudden changes of from 16 to 63 per cent., and the resulting speed variations immediately after the changes ran from 1 to 1.9 per cent., and then settled down to from 0.4 to 1.3 per cent.

With the electrical governor and sudden changes in load of from 12 to 62 per cent., the average variation in electromotive force was 1.1 per cent., whereas the contract specified 1 per cent. with 25 per cent. change of load.

When the magnitude and suddenness of the changes made in the experiments are considered, the observed results more than satisfy all reasonable requirements.

The drop in voltage when increasing the load from nothing to full inductionless load, the speed and excitation remaining constant meanwhile, was not to exceed 6 per cent. The actual drop was only 1.02 per cent.

With an inductive load, the other conditions remaining the same, the drop was 11 per cent., which may be regarded as a favourable showing.

After a run of six hours, the rise in temperature of any part of the generator or exciter was not to exceed 40° C. This figure was overstepped only in the core of the generator armature, where the temperature rose 48.5° C, but this slight fault will be remedied by the builders, who will increase the ventilation of the armature.

The Bremer Arc Lamp.

In the two decades during which the electric arc-light has been a commercial reality, it has made no startling progress. It is true that the regulating mechanism has grown better and more even in its action, the life of the carbons has lengthened, particularly since the introduction of the enclosed arc, lamps are run on low tension circuits and other improvements in detail have been made, but the efficiency of the light has increased hardly at all, and its colour is still the bluish-violet that it always has been.

The small progress made by the electric light in comparison with the incandescent gas light, employing the Welsbach mantle and similar devices, has enabled the latter to become a dangerous rival to electric illumination, and although there are great inherent advantages in the electric light, it must be made more efficient and cheaper if it is to drive its competitor from the field.

There have been many attempts at treating arc-light carbons by impregnation and in other ways, which have had the effect of making the arc burn more quietly and imparting a somewhat better colour to the light, but no striking results have heretofore been achieved.

But according to some tests made by Herr W. Wedding, whose experiments are recorded in the *Elektrotechnische Zeitschrift*, a decided advance has now been made by Herr Bremer, who prepares carbons containing from 20 to 50 per cent. of non-conducting salts of metals, such as calcium, silicon and magnesium.

The first measurements made were of a continuous-current arc lamp taking about 12 ampères. The positive carbon was the only one specially treated and it contained a calcium compound. In the article just mentioned are given tables and curves of illumination at various angles with the horizontal, from which it appears that when no globe was used, the mean hemispherical intensity of the light was 4,320 candles. The

average current through the lamp during the run was 12.3 ampères, the mean electromotive force 44.4 volts, so that the average power used was 546 watts, or 0.126 watt per candle.

The same lamp with a globe had a hemispherical intensity of 2,772 candles and used 543 watts, or 0.196 watt per candle.

The second lamp tested is similar to one now hung on the Eiffel Tower, in Paris, at an elevation of 95 meters. It has four arcs, takes about 60 ampères of continuous current, and the positive carbons contain a calcium compound, as before. On account of the great intensity of the light the tests had to be conducted at night and in the open air. The lamp was hung 8 meters above the ground, and the illumination was measured on a surface 1 meter from the ground and at different distances from the lamp. From the observed results it was found that the maximum intensity of the light when no globe was used was 83,000 candles, at an angle of 37 degrees below the horizontal, while the mean hemispherical intensity was 49,730 candles. The average current was 55.8 ampères, the electromotive force 89.3 volts, so that the power used was 4,980 watts, or only 0.1 watt per candle. When covered with a globe, the hemispherical intensity of the light was found to be 26,890 candles, and the power used 4,610 watts, or 0.17 watt per candle. From the above figures, it appears that for the arc lights without globes the power used was hardly more than 0.1 watt per candle. Herr Wedding states that the lowest power consumption he had ever found with other kinds of lamps was 0.3 watt per candle, and that the average was between 0.4 and 0.5 watt. The new lamp, therefore, is three times as efficient as the best of the old ones, or, putting it another way, with the same power three times as much light is produced.

An alternating-current arc lamp with one of its carbons treated by the Bremer process was measured without a globe and found to have a mean intensity of 512 candles and to use 0.5 watt per candle. This shows a decided improvement on previous alternating-current arc lamps, and it is believed that with better construction even more favourable results can be obtained.

The regulating mechanism, which works smoothly, is much simpler than in the ordinary kinds of lamps, but the details are not yet ready for disclosure. In the ordinary lamps most of the illumination comes from the glowing carbons, but in the new lamp the arc itself furnishes considerable light, and so makes a more even distribution of illumination. Above the arc and surrounding the upper carbon is a conical tin hood, which helps to retain the heat generated in the arc and also acts as a reflector. Some of the products of combustion settle on the inner surface of this hood in the form of a pure white powder which makes an admirable reflecting surface and helps in the even distribution of light, so that the lamp globe, when on, appears uniformly illuminated and the upper half is not in the shade, nor are sharp shadows of the negative carbon and its holder cast on the lower hemisphere.

Favourable photometric measurements alone do not make a lamp successful. Much depends upon the æsthetic impression which the light makes on the eye, and in this respect the new lamp is not wanting. The large amount of calcium contained in the carbon gives rise to a rich yellow-red radiation, in contrast with the usual bluish-violet rays of the arc, so that the light has a much warmer tone. According to the inventor, the colour of the light can be regulated at will by varying the composition of the carbons.

The richness in red rays of the Bremer lamp led Herr Wedding to try some experiments to determine how well it could penetrate fog and mist. He took a lamp of the ordinary kind and a Bremer lamp and interposed a cloud of steam about 1 meter thick between them and a photometer. Repeated observations showed that the penetration of the new light was twice as great as that of the old. This result points to the applicability of the Bremer lamp to lighthouses and signal lights where the penetration of fog is of consequence.

A Steel-Pipe Bridge.

THE Société Electro-Métallurgique Française is engaged in the production of aluminium, pure and in the form of alloys, of silicon, of carbide of calcium, and so on. It has four large plants, one of which is situated at La Praz, on the line of the Mont

Cenis Railway, in the department of Savoy. The La Praz works are situated on the bank of the Arc river, from which power is obtained. The water is led to the plant by means of two steel conduits, one of which is 1,200 meters long and 2 meters in diameter, and the other 1,000 meters in length, with a diameter of 2.4 meters. The former, or low-pressure conduit, gives a head of 33 meters, the latter, the high-pressure one, delivers the water with a head of 72 meters. At the generating station are turbines with a total horse-power of about 12,500, running twenty-eight continuous-current dynamos and alternators of various sizes.

Perhaps the most remarkable part of the plant is the high-pressure conduit already mentioned, both from the fact that it transmits 10,000 horse-power and because of the way in which it crosses the Arc river. Its diameter is 2.4 meters (7 ft. 10.5 in.) from the intake to the pen-stock; the diameter of the latter decreases from 2.4 to 1.8 meters. The speed of the water in the conduit is about 2.75 meters per second. The steel plates of which the pipe is constructed have a thickness varying from 5 millimeters at the intake to 15 millimeters at the pen-stock, though a few sections at the springings of the arch across the river are 16 millimeters thick. The pipe has no expansion joints, the curves which occur in the course of its length taking up any expansion. For the most part it is laid right on the ground or in shallow trenches, but in a few places, in order to avoid too sharp curves, it is carried above the ground on masonry columns. The total weight of the pipe is about 785,000 kilograms (400 tons).

At one place the conduit had to cross the river, and it was decided to carry it over in the form of a flat arch, with a clear span of 50 meters. The arch was erected on staging placed in the bed of the stream and was built out from both abutments until the parts met at the key-ring. The sections of pipe practically imbedded in the abutments have circular and longitudinal flanges in order to prevent any displacement. The abutments themselves are of concrete, reinforced by bands of iron.

Besides carrying its own weight and that of the water flowing through it, the tubular arch supports a foot-way with railways, and, according to M. A. Lapouche, from whose article in the *Génie Civil* this account is taken, the structure has proved to be a happy solution of the problem involved.

The Elbe-Trave Canal.

SOME years ago it was thought that canals had outlived their usefulness and that they could no longer successfully compete with railroads. But more recently there has been a change of sentiment, as is evidenced, among other ways, by various plans for the improvement of the Erie Canal and by proposals for canals to connect the Mississippi Valley with the Great Lakes. In Germany the renewed interest in canals has been particularly great. Not to mention the great Kiel ship canal, connecting the Baltic with the North Sea, which is primarily a strategical work, there is now under construction, or proposed, a system of commercial canals connecting all parts of the interior of the Empire.

One of the links of this system is the Elbe-Trave canal, which was formally opened in June. This canal runs from Lauenburg, on the Elbe, to the old Hansa city of Lübeck, on the Trave, which flows into the Baltic, and is of special importance to the latter city, which thus secures an adequate water connection with all that part of Germany reached by the Elbe, its tributaries and its canal system. A canal between the Elbe and the Trave, the so-called Stecknitz Canal, has existed since the end of the fourteenth century, but though it formed the main artery of trade from the Elbe through Lübeck to the Baltic region for a couple of centuries, its usefulness afterwards decreased, and latterly it has been entirely inadequate for the demands of modern commerce.

Plans for its improvement or for a new canal between its terminal points have been proposed from time to time, but have met with many obstacles, partly owing to the fact that the line runs through, or adjacent to, the territory of four different States—Prussia, Lübeck, Mecklenburg-Schwerin, and Mecklenburg-Strelitz. But finally all the preliminary difficulties were overcome, a plan was settled on, and work was begun about five years ago.

The canal, according to the *Zeitschrift des Vereines Deutscher Ingenieure*, is 67 kilometers (42 miles) long. The distance

from Lübeck to the summit level is about 26 kilometers. There are five locks on this section with a total lift of about 12 meters (39 feet), the elevation of the summit level above the sea. The summit level is 30 kilometers long, and the canal then runs to the Elbe at Lauenburg, a distance of 11 kilometers. There are two locks on this section, the descent from the summit to the Elbe varying from about 7 to 8 meters. The present bottom width of the canal is 22 meters and the depth of water 2 meters, and it is purposed to increase these dimensions to 27.3 meters and 2.5 meters, respectively. The western bank has been permanently finished, but the eastern bank has been only temporarily built, in order to allow for the enlargement. The tow paths are 2 meters above the water level; the eastern one is 2 meters wide and the western or principal one 3.5 meters. On the latter a system of electric haulage will be provided later.

The locks are 80 meters long and 17 meters wide, with gates 12 meters wide and have 2.5 meters of water on the sills. They are built on the Hotopp plan, and are filled and emptied and have the gates operated by a hydraulic and pneumatic system. The largest boats which run on the canal are the Elbe barges, 78 meters long and 11.5 meters wide, with a capacity, when drawing 1.75 meters (5.75 feet), of 1,000 tons.

The cost of the canal was 23,554,000 marks, of which 7,500,000 marks were contributed by Prussia and the rest by Lübeck. The operating and maintenance charges will be borne by the two States in the same proportion as the first cost was.

German Central Station Statistics.

ACCORDING to its annual custom the *Elektrotechnische Zeitschrift* has recently published tables showing the condition of the central stations in Germany on March 1, 1900, with editorial comments thereon. These tables cover, as far as possible, all central stations which publicly furnish current for lighting and power purposes, but do not include private plants or generating stations which supply current exclusively for railway work. Stations which furnish current for both lighting and railway operation are, however, included, and are properly designated in the tables. The columns of the principal table give the name of the station and its owners, the place where it is situated and the number of inhabitants thereof, the system used—whether continuous-current or alternating-current, or some other—the motive power, the capacity of the generators, the capacity of the secondary batteries, where used, the number of incandescent lamps connected, the number of arc lamps, the horse-power of the electric motors operated, the number of meters, the date of opening, and remarks, which often give the electromotive force used.

According to the reports sent in to the *Elektrotechnische Zeitschrift*, there were in Germany, on March 1, 1900, 652 electric central stations, contrasted with 489 on the same date last year, or an increase of 163. There were 122 in course of construction, 17 of which were to be finished by July 1, at which time the number completed thus amounted to 669. This figure is probably below the actual total, as no answer was returned to some of the requests for information sent out to central stations. Of all the stations in operation on March 1, 625 were built in the last decade, and only 27 were in existence before the end of 1889.

The number of central stations differs of course from the number of communities lighted by electricity, for on the one hand there are cities which have several electrical works, and on the other, it sometimes happens that one station supplies current to a number of towns and villages. In this latter respect there lies one distinct advantage of electric over gas lighting, for while the latter is confined to a comparatively limited area surrounding the gas works, the electric current can be led to considerable distances with little loss and at small expense, and can be conveniently distributed from a single central station to many places which could not support a gas works. In some cases as many as 30 communities are lighted from one central station. Although the number of electric stations does not yet quite equal the number of gas works in Germany, the communities supplied with current for electric lighting are even now more numerous than those provided with gas, there being about 900 of the former to 850 of the latter.

The tables show that 80.4 per cent. of all the central stations supplied continuous

current only, but that the capacity of their dynamos is only 47.4 per cent., and the combined capacity of their dynamos and accumulator batteries only 53.8 per cent. of the total output of all stations. The percentage of continuous-current stations to the whole number remains about the same as last year, while their proportionate capacity has fallen off somewhat. The continuous current, however, has not yet lost its commanding position in Germany. A closer inspection of the statistics shows that while the absolute number and capacity of continuous-current works has increased decidedly, the corresponding figures for the alternating and polyphase stations show only a slight enlargement. There is, though, a very great increase in those works which supply both continuous and polyphase currents, or in which the primary polyphase current is transformed into continuous.

Almost all (93.1 per cent.) of the continuous-current stations have storage batteries, a slight increase over last year. The storage-battery capacity of these stations is 37.9 per cent. of their dynamo output, and is 20 per cent. of the dynamo capacity of all kinds of central stations.

The number of single and two-phase alternating-current stations has increased during the past year from 33 to 42, and their capacity from 17,826 to 21,573 kilowatts. There are now 39 works furnishing polyphase current exclusively, as compared with 33 last year, and their capacity has risen from 29,715 to 35,150 kilowatts, or 18.39 per cent., whereas in the previous year the gain was 109 per cent. Besides these exclusively polyphase works, however, there are at present 38 combined polyphase and continuous-current stations, against 22 last year, their capacity now being 46,608 kilowatts as compared with 25,970 last year. The number of combined alternating and continuous-current stations has changed from 5 to 6, and their capacity risen from 1,011 to 1,700 kilowatts. In two works, with a combined capacity of 790 kilowatts, current is supplied by monocyclic generators.

It is but natural that steam should be the principal motive power, as there is a lack of available water power in Germany. The stations operated entirely by steam are 382, or 58.6 per cent. of all, and their capacity is 146,624 kilowatts, or 76.5 per cent of the total, just about the same proportion as last year, when the percentages were 59.9 and 76.5, respectively. The number of works run by water power is 74, or 11.4 per cent., as against 11 per cent. last year, while their capacity is 15,674, or 8.2 per cent. of the total, compared with 10 per cent. in 1899. When it is considered that among these water-power stations is counted the largest electrical plant in Germany, the power-transmission works at Rheinfelden, with an output of 12,000 kilowatts, and that therefore the remaining 73 water-power stations have a combined capacity of only 3,674 kilowatts, it can be seen that, in general, only very small plants are driven exclusively by water. As a rule, those stations which have water power have steam power besides. There are 144 of such works, with a capacity of 26,674 kilowatts, the corresponding figures for 1899 being 103 and 17,201, respectively. In many cases, however, either the water or steam power is used only as a reserve. Although the number of stations driven by gas shows a not inconsiderable increase from year to year, having risen in the past twelve months from 21 to 29, their capacity, 1,881 kilowatts, is not yet as much as 1 per cent. of the total. Gas engines, however, are used as a reserve in some of the smaller steam and water-power stations.

One of the tables groups the stations according to their capacity. From this it appears that 306 plants have a capacity, including dynamos and accumulators, of 100 kilowatts and under; 249 are between 101 and 500 kilowatts; 31 between 501 and 1,000; 29 between 1,001 and 2,000; 17 between 2,001 and 5,000; and 6 are over 5,000 kilowatts. The capacity of 14 of the stations on the list is not known. The 23 largest works, including the one at Rheinfelden, have a combined capacity of nearly 100,000 kilowatts, or 43.1 per cent. of the total. In some of these twenty-three, however, part of the current is used on street railways, and at the Rheinfelden works nearly three-quarters of the energy is employed for electrolytic purposes.

The points cited in this review are only a few of the many interesting ones brought out in the tables, to which the reader is referred for details.

REVIEW OF THE AMERICAN PRESS

Topography of the Nicaragua Route.

A VERY important contribution to the literature of the isthmian canal is supplied by *Engineering News* in the form of a condensation, by Mr. E. S. Wheeler, C. E., chief engineer of the Nicaragua-canal commission of 1897-1899, of the report of that commission. The result of their work has been so inaccessible that this brief presentation, even without the data, discussion, or recommendation, is most welcome.

Mr. Wheeler at the outset makes very plain the general topography of the region, which is "geologically recent and therefore very clear." There are three principal mountain ranges. Farthest to the north lie the Nicaraguan highlands, having peaks 5,000 to 7,000 feet in height; farthest south are the Costa Rican mountains, rising to 11,000 feet. These two ranges "overlap each other for about a hundred miles, their crest lines being parallel to each other and about seventy miles apart. Between them lie the San Juan valley and river," extending from Lake Nicaragua in a southeasterly direction to the Caribbean Sea. This valley is about eighty miles long, about twenty-five miles wide between the foot hills, with a floor rising gradually from the Caribbean Sea to an elevation of 200 feet at Castillo, and thence declining gently to about 100 feet at the lake. Transversely, it rises toward the foot hills at the rate of about four feet to the mile. Through the Castillo crest the San Juan river has cut its way, in a gorge which in its central part is more than 100 feet deep. Any canal having its lake for its summit level must pass through this gorge, or make an artificial cut 50 miles in length and with depths exceeding 100 feet, which is, of course, out of the question. "The area in which a canal is feasible is thus confined to very narrow limits and the problem of location is greatly simplified." The difficulties to be met in this point are those attendant on the canalization of the San Juan, especially the location of dams and the control of the flood waters of the San Juan and San Carlos. In this stretch Mr. Wheeler proposes three dams—at Machuca, Conchuda, and Boca San Carlos—in place of the one huge Ochoa dam proposed by Mr. Menocal. At each dam would be a lock with a lift of about 18 feet, the uppermost one varying from 18 to 24 feet with the varying level of the lake. Below the gorge and thence to the Caribbean Sea, the San Juan valley is filled by the flood plain of the river, merging insensibly into the delta. It has a slope of 1½ feet to the mile, is covered during the wet season with several feet of water, and consists in the upper part of yellow clay, with a shore belt of black sand sometimes two or three miles in width. The entire plain is very uniform, four different canal routes run across it showing almost the same estimated cost per mile in every case. Canalization of the San Juan below this point is impossible on account of its great volume and heavy burden of detritus, and "the great depth to suitable foundations for dams." The problems here are the crossing of the tributary valleys (minimized by locating the canal in the narrow plain between the river and the Nicaraguan hills), the location of the locks, and the construction of a harbor in a delta which is pushing seaward at the rate of 75 feet a year. Three locks are to be placed in this section. Mr. Wheeler makes no comment upon their location, nor upon the possible difficulty of finding foundations in the delta-plain. He says of the entire location: "It is believed to be very nearly as good as any that can be made * * * more minute surveys may make minor changes, * * * but it is not believed that any changes can be made that will diminish (the cost) as much as 10 per cent."

So much in brief for the eastern slope. Mr. Wheeler lays emphasis upon the point that the San Juan valley, in which this eastern stretch of the proposed canal lies,

"is not a break or low pass through a mountain range, but a region or valley lying between the distinct and widely-different mountain ranges." At one time this valley extended through from ocean to ocean. What is now the enclosed and elevated basin of Lake Nicaragua was an ocean bay, lying behind a long point formed by the northwesterly end of the Costa Rican mountains. The West Coast volcanoes—the third principal mountain group referred to at the outset by Mr. Wheeler—broke out in the sea, substantially midway between the parallel ranges of the Nicaraguan highlands and the Costa Rican mountains, and extending across from one to the other, shut in the valley between them at its northwestern end, enclosing Lakes Managua and Nicaragua. At that time the discharge of Lake Nicaragua was westward into the Pacific, and so continued long enough to wear down in the solid rock a gorge 20 to 40 feet deep and 3 to 4 miles long. The clays of the eastern ridge, however, wore away still faster; streams flowing westward into the lake from about Castillo worked down through the low ridge of the divide, and the outlet of the lake was turned eastward, with resultant lowering to a level 50 feet below its former westward outlet. To the Pacific, therefore, there is no outflowing stream which can be canalized. The valleys of the Lajas, rising from the lake to the divide, and of the Rio Grande, falling from the divide to the Pacific, are, however, "so much lower than any other pass between Lake Nicaragua and the Pacific that they alone need be considered in connection with a canal." A rock-cut of 10 miles to Buen Retiro (reversing the flow of the Lajas) would extend the summit-level to that point. Four locks in the 7 miles of canal between this point and the ocean would lower the canal the entire distance on the western side. The key problem may best be summed up in Mr. Wheeler's words: "From the preceding the reasons for the final choice of location will be readily understood. It has been shown that the canal location on the west side must be in the valley of the Rio Grande and Las Lajas, and on the east side, between Lake Nicaragua and the San Carlos, it must be in the gorge of the San Juan.

"The first and most important question to be answered is, whether or not the gorge of the San Juan can be utilized for a canal with the river San Juan still flowing through it, and it is one that has never been adequately discussed.

"The reason for this seems to be that the early canal engineers assumed the maximum flow in the San Juan, where it leaves Lake Nicaragua, to be 18,000 cu. ft. of water per second, and not very much increased by its tributaries until it reached the San Carlos." Such a discharge as this would make a maximum velocity less than 2 ft. per second, which would not interfere with the safe passage of ships; therefore it was considered that the gorge could be used for canal and river simultaneously.

The Canal Board of 1895 was the first to point out that this maximum flow was greatly underestimated.

"The results obtained by the commission of 1897-99 show that the discharge from Lake Nicaragua often reaches 50,000 cu. ft. per second. The drainage into the San Juan above the San Carlos also reaches 50,000 cu. ft. per second, so that the discharge of the San Juan above the San Carlos often reaches 100,000 cu. ft. per second, and there is conclusive evidence that floods greater than this have occurred.

"It was also found that such floods would make a velocity in portions of the canalized river of more than 6 ft. per second. It is believed this would make navigation impossible for the time being and would also erode the banks and fill up the artificial channels, so that the canal would not be usable after the subsidence of the flood until portions were re-excavated.

"If such floods are uncontrollable the gorge of the upper San Juan cannot be used for a canal. With a flow of only 18,000 cu. ft. the river could be canalized, but with 100,000 it cannot. The means for controlling these floods are three: (1) By dams and wasteways in the San Juan river, which will temporarily retain the water in Lake Nicaragua and allow it to flow out at a limited rate; (2) by enlarging the cross-section in the San Juan river until its flood velocity ceases to be injurious; (3) by the creation of a new wasteway on the Pacific side, and thus withdrawing the larger portion of the flood from the San Juan river.

"Any one of these methods, if employed alone, would involve a cost that would be practically prohibitive. The minimum cost is found by a judicious combination of the three. * * * With these conditions it is found possible to reduce the maximum flow in any part of the San Juan to less than 30,000 cu. ft. per second, with a velocity less than 2 ft. per second, which it is believed will not seriously impede navigation or erode the channel banks. The question, therefore, as to whether the gorge of the upper San Juan can be used for a canal with these conditions may be answered in the affirmative."

The estimate based on this project, including harbors sufficient "for canal purposes only," is a little in excess of $130,000,000. Mr. Wheeler points out in conclusion that the opinions given and methods proposed are those of the chief engineer, which do not in all cases coincide with those of the commission.

"The commission proposes (1) a single high dam in the San Juan river instead of three low ones; (2) to permit 85,000 cu. ft. of water per second to flow through the canalized portions of the San Juan instead of limiting it to 25,000; (3) to limit the flow westward to the Pacific to 15,000 cu. ft. per second instead of increasing the capacity of the wasteway to 35,000 cu. ft. per second. In addition to these points of difference, the unit prices here given and the methods of obtaining them are not fully approved by the commission."

On the whole, it is scarcely an enthusiastic argument for the Nicaragua canal. The difficulties of canalizing the San Juan, and of dealing with the volumes of sand brought down to the Caribbean Sea are perhaps thrown into clearer relief than they have ever been before. Mr. Wheeler's paper adds keenness to the interest with which the report of the latest commission is awaited.

Communication with the Orient.

WHILE not properly to be classed as an engineering periodical, the *North American Review* offers two articles, both dealing with important phases of the far-eastern question which is so engrossing at present, and both closely concerned with engineering development.

The first, by Mr. Eugene T. Chamberlain, U. S. Commissioner of Navigation, entitled "Ocean Transportation to Eastern Asia," is an exhortation to the marine interests of the United States to awaken to their opportunities before other maritime nations have seized upon them. The advantages of access lie with the American Pacific ports. Hong Kong is 7,903 sea miles from Marseilles, and but 6,086 from San Francisco; Manila is 7,906 miles from Marseilles and but 6,254 from San Francisco; from Shanghai to Marseilles is 8,758 miles, to San Francisco but 5,550; between Yokohama and San Francisco the distance is but 4,564 miles, against 9,476 miles from Yokohama to Marseilles. The Suez canal routes from Europe also impose a toll, amounting in the average to one dollar per ton of cargo, going and coming, for a full-laden ship. Against this must be set the coaling opportunities of the Suez canal route; a Trans-Pacific steamer must carry coal for the full voyage, at the expense of cargo room; Europe further "enjoys the advantages of cheaper ships and lower cost of operation for its merchant ships." But with the increase of the size of ships and of the economy of coal consumption, and with large and fast steamships on the Pacific, "the United States have the advantage of nations which must use the Suez canal."

Mr. Chamberlain, however, deplores the slowness of his country to see and avail itself of its opportunity, and the comparative enterprise of other nations. "The German Cabinet report which announced to the Reichstag the purchase of the Carolines and the Ladrones (except Guam) was accompanied by a chart showing the new lines by which the North German Lloyd Steamship Company proposed to bind these islands, whose purchase at that time had not been ratified, to other German possessions in Asia." "Japan * * * for some time has had in operation to the United States 17-knot steamships of 6,000 gross tons, the largest and fastest vessels now employed on the Pacific Ocean." "Europe has been preparing * * * for the competition for several years."

He points out the increasing deficiency of tonnage on the Pacific, and asks: "Is this lack of tonnage to be supplied by American vessels, or do we purpose at the

outset voluntarily to abandon the carrying trade of the Pacific to our foreign rivals, who have already acquired control of the Trans-Atlantic trade?"

"The ocean-carrying trade of a nation," Mr. Chamberlain concludes, "is as much a national industry as any manufacturing process." In the fatuous policy of "protecting American ship building" during the last thirty-five years, however, the United States have almost succeeded in destroying the vastly greater industry of sea carrying; 39 clearances out of 5,390 in the trade from the United States to Europe in 1899 were under the American flag. Now England, Germany, and Japan are taking the trade of the Pacific. How long will it take the United States to awaken?

Immediately following Mr. Chamberlain's article is one by Mr. Chandler Hale on "The Projected Cable Line to the Philippines," forcefully supporting the argument for a non-national line by the northern route which was so ably presented in these pages by Mr. Harrington Emerson in November last.

Mr. Hale points out first the roundabout line of communication which is now the only one open to the new possessions of the United States, and the imperative need for something better. The proposed southern route, however, would cost at least $21,000,000, and with a branch line from Guam to Japan, the cost would exceed $25,000,000. Japan, however, in Mr. Hale's view, would not permit a foreign government to land a cable on its shores; the branch line to capture the Japanese business, so essential from a commercial point of view, would, therefore, be impossible; a government line could not hope, either, to expect any business west of Manila, and would have to its credit in annual business only the saving of about $400,000 now expended yearly in official cabling to the Philippines and an additional $150,000 of (estimated) Hawaiian business. Against this yearly revenue of $550,000 would stand annual maintenance expense of more than $1,550,000. But for a guarantee of $400,000 yearly for transmission of government messages, "a sufficient number of responsible individuals and companies are willing and even anxious to secure the permission to establish this entire cable."

Turning then to the northern route, Mr. Hale shows, as Mr. Emerson did, its enormous advantages, in that it avoids great depths and great length of individual links. An international cable by this line would cost but $6,000,000. It would lie in latitudes all lower than that of Aberdeen, and in climates far superior to that of the North Atlantic. A single spare cable of 850 miles would replace any link. Repairs could be made at any time of year, and repair ships could find harbor within 120 miles of any break. Mr. Hale ends with a remarkable summation of the advantages of Dutch Harbor as a strategic point. "A map with concentric circles will show that Dutch Harbor is the great central port of the North Pacific, and that Hawaii is the most out-of-the-way place in the northern hemisphere."

A cable is essentially a commercial bond, and will be of infinitely more value to the world and to its owners if established on commercial lines than if undertaken in a spirit of militant nationalism.

German Iron Markets.

THE menace of prevalent conditions in the American iron trade has been lately pointed out in this magazine, and a remedy indicated. Both in the editorial prefacing Mr. Jean's article in our July issue, and in Mr. Hull's able paper in our August number, American iron-makers were exhorted to reduce prices as a measure tending to stability and protection against coming depression.

In the *United States Consular Reports* Mr. Frank H. Mason, Consul-General at Berlin, shows the curious correspondence which exists between German and American conditions, with, however, an equally striking distinction. In Germany, also, "railway and bridge building, and car, railway, and ship construction," all "have been restricted by the high cost of iron and steel," and "makers of hardware and many small articles of iron and steel have been compelled almost to suspend operations by the high cost of materials." And the very next statement is that "the period of highest activity in the metal industries has been reached, and although business is still brisk and many establishments filled with orders for some time to come, the average period

of delivery has been reduced in some cases from six or eight months to as many weeks."

The *Berlin Boersen Courier* therefore advises the German producers of pig iron to "reduce their selling prices at once." "Iron masters' syndicates are now besought to gradually and steadily reduce the selling prices of their product to the lowest reasonable figure, and thus not only keep the home market in their own hands, but increase thereby the consumption of metals."

There is an argument and a threat in this; the appeal to "increase the consumption of metals" is addressed to the reason; the hint to "keep the home markets" is designed to work on the fears of the German iron-makers—and not without foundation. "The recent drop in the price of American iron and steel," says Consul-General Mason, "has produced a general feeling of apprehension among the iron-masters and holders of industrial securities in Germany and Great Britain." They "have clearly seen the day when, the stress of an abnormally active home demand being satisfied, the European markets would have to meet the attack of an American surplus, manufactured under every advantage of cheap, abundant materials, low freightage, and the highest, most effective substitution of machinery for human labor." Sales of 4,000 tons American pig iron at 73s. ($17.01) per ton delivered at Hamburg and the offer of a "large shipment" at 84 marks ($20) per ton c. i. f. Amsterdam made German furnace men think the hour of danger had come. There are prices with which German irons can still fairly well compete, but with cheaper ocean freights—which Mr. Mason thinks are certainly to be expected—what will be the situation? Germany's export trade of 180,000 tons—chiefly to Belgium—"is already as good as lost."

Mr. Mason's review of the situation suggests magnificent possibilities for the American iron-maker. He implies a belief that a still more far-sighted policy would dictate that the iron "should be worked up at home and only the ultimate finished products exported." The one weak point of the American position he considers to be "lack of tonnage under their own flag." We might add lack of stability in market conditions, and lack of attention to foreign markets, except spasmodically under the stress of extraordinary situations at home. Probably this last is even more important than the first. With a constant, intelligent campaign, there are certainly enormous possibilities for American iron and coal on the Continent. As the *Statist* puts it: "Over and above all, the shadow of America is towering over the market."

The Economy of Rapid Building.

THE "sky-scraper" seems to have exerted a revolutionizing influence in building methods—and, indeed, in the way of looking at building operations and at buildings themselves—which is almost as remarkable as these tall structures are when regarded simply as elements of a city sky line. They are typical of the spirit of the age—the effort at the utmost attainable economy, and the larger possible output from a given plant. In this case the plant is the piece of ground to which modern city conditions have given extraordinary value as a rent-yielder. "The building is merely the machine which makes the land pay," says Mr. Cass Gilbert in the *Record and Guide* (our quotation is from a republication in the *Engineering Record*). "The more economical the machine, both in construction and operation, provided it fulfils the needs, the more profitable the land."

It is economy in construction, in so far as this is secured by rapid erection, which forms Mr. Gilbert's main theme. Taking the Broadway Chambers, New York, as a text, he puts the practical, financial aspects of the construction of a huge building of this sort in a new and striking light. This structure, 50 by 95 feet in plan and eighteen stories high, was contracted for on March 1, 1899, and was completed and occupied by tenants May 1, 1900. Old buildings on the site had to be torn down, neighboring buildings and streets supported, foundations put in, materials prepared and assembled, and the construction itself completed within this time. Much trouble was experienced under the second head, and it was October 1 before the steel columns for the basement were set. By Dec. 7 seventeen stories of steel were in place and the frame was completed Dec. 31. Feb. 1,

masonry was completed to the cornice and glass was in place for fifteen stories. On April 27 tenants began to move in. But, as Mr. Gilbert says in summing up:

"Rapid construction is not undertaken merely for the purpose of making a record. It is a necessity arising from economic conditions. The value of land is an important item in construction. Many an owner hesitates to tear down an old building and encounter the expense of a new one, when he realizes that in the process of the change he will, probably, lose from one to two years' rent, thus losing the interest on the money already invested in the land. To minimize this loss, then, becomes a most important factor in the financial scheme of the enterprise. Assuming, for instance, that the value of the land upon which the building is to be erected is placed at $1,500,000, the interest thereon, at 4 per cent., is $60,000 per annum. If two years are consumed in construction of the new building, it will have cost in interest $120,000, to say nothing of the loss of rental on the old building. Moreover, if interest is charged on the cost of building from time to time as payments are made to the contractor in the course of its erection, this account is greatly increased. Presuming the cost of the building to be $1,000,000, and paid in, say, ten payments of $100,000 each, at intervals during the two years, this interest account would be made up somewhat in this way:

Interest, two years, on $1,500,000 at 4 per cent.	$120,000
Interest on installments of $1,000,000 at 4 per cent.	30,000
Total	$150,000

or 15 per cent. on the cost of the new building. I have used the 4 per cent. rate in this illustration because that is the common rate of interest on first-class mortgages, but I have known some important instances where the money was obtained at 3½ per cent., or even less. It is obvious, whatever the rate, that the new building should be constructed as rapidly as possible or as is consistent with good workmanship, to save as large a proportion of this interest as possible, and to make the enterprise begin to earn as soon as possible. For these reasons, then, and not for the purpose of merely making a record in rapid construction, such a building should, if practicable, be erected within a year. It is of comparatively small advantage to finish it within fourteen or sixteen months; for, assuming that rents are negotiated from May 1, the building must be completed before the first of next May, or carried over into the autumn. In order to accomplish such rapid construction drawings must be prepared considerably in advance, and the contracts should be let at least two months before the work is to be begun. This gives the contractor an opportunity to get the structural steel and other material under way in the shops, and have it ready when needed, and two months are the very least that should be allowed for this.

"Speaking of such enterprises from the financial aspect, it is a rule that holds almost invariably, that where the building costs less than the land, if properly managed, it is a success, and where it costs more than the land it is usually a failure. The land value is established by its location and desirability from a renter's standpoint; hence high rentals make high land values and conversely. * * * In my judgment, the best equation of building and land is that the building should represent about two-thirds of the land value under normal conditions."

Electric Train Lighting.

ELECTRIC lighting of railway trains has advantages so marked for this special purpose that, particularly in view of the strong tendency toward luxury in American travel, it is somewhat to be wondered at that its introduction has not been more general. Mr. George D. Shepardson, in the *Electrical World and Engineer*, summarizes these advantages as being "freedom from dripping and smell, smoke, and other products of combustion, open flame and danger from fire, and its uniformity, reliability, flexibility and general adaptability."

His paper, however, makes it plain that if the use has not become widely general, it has at least been highly perfected in special cases, the one he selects being on the Chicago, Burlington and Quincy road between Chicago and the twin cities, St. Paul and Minneapolis. The six roads join-

ing these cities, while varying a good deal in mileage, have a uniform agreement as to minimum time and fare; the rivalry, therefore, centers largely in matters of equipment and comfort.

The C., B. & Q. was one of the first roads to experiment with electric lighting, but their efforts in 1886 were not satisfactory in the matter of cost, largely on account of the experimental state of the storage battery at that time. Eleven years later the work was revived with much better success. Mr. Shepardson expresses the belief that "with batteries charged at terminal stations under the best conditions, the total cost of lighting a train by electricity is less than by gas. It may possibly be reduced in the case of trains whose batteries are charged from dynamos driven from car axles, and probably yet more by making certain structural changes in the batteries.

"There are several systems of supplying current for railway trains, and each has its own field, being best suited for certain conditions. No one system is best for all. For solid through trains, such as those running between Chicago and Minneapolis, the ideal conditions prevail for the use of storage batteries. The night trains stand in the yards all day, and, while the car cleaners and inspectors are doing their work, the batteries can be charged without being removed from the cars, and without holding the cars from service a single moment. All handling of the cells, except as required for repairs or cleaning, is avoided, thereby removing one of the most prolific causes of deterioration found in some earlier attempts to use storage batteries for train lighting, as it was found that a single removal and replacement of the battery injured it more than a thousand miles of travel. In the case of the limited trains leaving in the evening and arriving in the morning, the battery is at its best; for when the train starts, the batteries have just received their charge, and the voltage is high, so that the lights are brightest when most needed."

The train taken by Mr. Shepardson as his example consists of five cars—a composite baggage and buffet, a standard sixteen-section sleeper, a compartment sleeper, a reclining-chair car, and a coach. The lighting is by both center and side fixtures. Pintsch lights are provided, but used only when the trains are in the terminal stations. The berth lamps are particularly convenient and useful, being of great comfort to those who wish to read, and under full control of the individual passenger.

"The total lighting of the train, exclusive of gas, is as follows:

	Lights.	Candle-power.
Buffet car.....	24	aggregating 368
Standard sleeper.....	74	" 824
Compartment sleeper.	45	" 576
Dining car.....	49	" 640
Chair car.....	30	" 408
Coach	31	" 420
Transparency	12	" 120
Total for train....	265	" 3356

"After a careful study of the conditions, the officials of the Burlington road decided that the system best adapted for their limited trains between Chicago and the Twin Cities was to use storage batteries charged at the ends of the line. Each car was therefore equipped with forty-eight cells of the Pullman and American type. The plates in the two kinds of battery look alike, the American being a pasted plate, while the Pullman is formed electro-chemically by the Planté process. The cells are rated at 160 amp.-hours, and each weighs about 56 lbs. Each cell contains four positive and five negative plates, each plate being 7 ins. high, 6 ins. wide and ½ (American) or ⅞ (Pullman) in. thick. The plates rest on treated wooden supports, clearing the bottom of the containing cells by about three-fourths of an inch. The hard rubber containing cells are 11 ins. high and 6½ ins. by 6¾ ins. wide, giving only one-quarter inch clearance between plates and cell. At first it was feared trouble might be caused by slopping of the acid when the train started or stopped suddenly, but by using deep cells extending about three inches above the tops of the elements, and by having little clear space on the sides, no trouble is experienced from that source. The 48 cells under each car are connected in series through rubber-covered flexible copper cables, and very little trouble is experienced from loose or broken joints. For convenience in handling, six cells are placed in a tray or crate with hardwood rollers and suitable handles. Four crates

are placed in each of two boxes under the car floor, one box being on each side, to equalize space and weight. When the train is on the road the boxes are closed tightly by cover lids hinged at the bottom, but when the batteries are charging the covers are dropped to allow the gases to escape freely. Practically no trouble is caused either by fumes when charging or by entrance of dust when on the road.

"On some of the cars, ammeter jacks are placed near the battery boxes to facilitate measuring the charging current taken by each car. The battery terminals lead to one of the closets in the car, to a cabinet containing switches and fuse blocks for the two or more circuits of the car, and also two clips for voltmeter connection, to facilitate testing the condition of the batteries. Three cables, No. 00 B. & S. G., run the entire length of the train, being connected between cars by flexible couplings at the tops of the vestibules. All the battery circuits and lighting circuits are connected across two of the cables, thus equalizing the discharge of the batteries, however the loads in the individual cars may vary. When charging, the dynamo is connected between the two outside cables, so that each battery is charged at practically the same pressure.

"When the train arrives at the terminus, the electrician removes the cable couplings between the cars, so that each car may be lighted from its own battery. All the lights are then turned on and the voltage or the appearance of the lights is noted to see that the batteries are in good condition. The failure of any cell is thus readily detected and the cell replaced. The flexible couplings between the cars are then replaced and the charging current is turned on, the lamps, of course, being turned off while the batteries are charging.

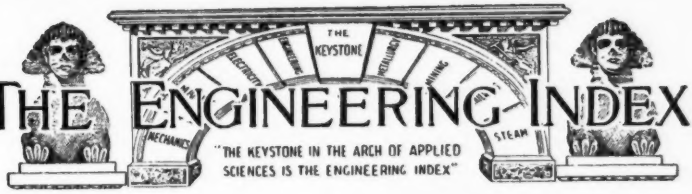
"At Minneapolis, the charging begins with 85 amperes at 110 volts, increases to 100 amperes at 115 to 130 volts, and then drops off to 85 amperes at about 132 volts.

"Since the train lies in the Chicago yards two hours shorter time than at Minneapolis, the batteries are charged at a higher rate, beginning with 115 amperes at 115 volts and ending with 120 amperes at 136 volts. The charging stops about an hour before the train starts, allowing the temporary excess polarization to die away, so that the terminal voltage is about 98 when the lamps are first turned on. With all lamps lighted the voltage soon falls off to about 97, so that the lamps are not strained for any considerable length of time. Since the number of lamps in use drops off during the evening, and the rate of discharge diminishes accordingly, the voltage remains nearly constant all night, and no kind of regulation is required to maintain practically constant voltage on the lighting circuits.

"About once a month the cells are removed from the cars for thorough inspection and washing. At such times a deposit of mud from one-eighth to one-half inch deep is removed from the bottom of each jar. In setting up the cells, acid with specific gravity of 1.150 is used.

"The excessive weight of storage batteries has been urged as a serious objection to their use for lighting railway trains. As a matter of fact, with the heavy vestibuled trains now common, the weight of the battery averages less than 2 per cent. of that of the car it serves, so that this objection has little force.

"After an experience of three years with the batteries, the master mechanic, who has charge of these trains, is convinced that electricity is far superior to other methods for lighting trains, and that the battery system is more economical than the engine and dynamo."



The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining any portions of this literature that may be desired by our readers.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. w. Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
Annales des Pontes et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, U. S. A.
Canadian Architect. *m.* Toronto.

Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer *s-m.* Cleveland U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *m.* New York.
Ice and Refrigeration. *m.* New York.
Indian and Eastern Engineer. *m.* Calcutta.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Journal Assn. Eng. Socities. *m.* Philadelphia, U. S. A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst.. Worcester, Mass.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland U. S. A.
Metal Worker. *w.* New York.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U. S. A.
Mining Reporter. *w.* Denver. U. S. A.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architects. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Proceedings St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Baths.

See Plumbing and Gas Fitting, below.

Ceiling.

A Steel Vaulted Ceiling. Illustrated description of a Gothic church roof of steel beams with metal furring. 700 w. Eng Rec—July 14, 1900. No. 35251.

Chimneys.

Standard Specifications for Chimney Construction (Einheitliche Bestimmungen zur Berechnung der Standfestigkeit von Schornsteinen). Standard regulations for calculating the stability of chimneys and the allowable wind pressure, compiled by a committee of the Prussian Society of Steam Boiler Inspectors. 3000 w. Zeitschr d Ver Deutscher Ing—June 30, 1900. No. 35305 D.

Dome.

Construction of the Metallic Dome of the Schneider Pavilion at the Paris Exposition (Exposition de 1900. Pavillon de MM. Schneider & Cie. Construction de la Coupole Metallique). Ch. Dantin. A very well illustrated account of the construction of this building, in which movable staging and travelling cranes were used. 2 plates. 3500 w. Génie Civil—June 30, 1900. No. 35392 D.

Durability.

The Durability of Buildings and their Parts (Bestanddauer von Objecten und Objectstheilen). Prof. J. Röttinger. A long continued article on the age of buildings and the causes which affect their endurance. Partly theoretical, partly giving results of experience. Serial. 1st part. 1400 w. Wiener Bauindustrie Zeitung—June 28, 1900. No. 35369 D.

Fireproofing.

Second Church of Christ, Scientist, New York City. Illustrated description of a fireproof structure containing unusual features of arrangement and construction. 2500 w. Eng Rec—July 7, 1900. No. 35151.

Fireproofing Wood. Illustrated description of the latest method, invented by Joseph L. Ferrell. 2500 w. Sci Am—July 28, 1900. No. 35529.

Tests of Fire Retardent Materials. Charles L. Norton. Describes experiments and tests carried out with a view to determining the efficiency of several means of protecting wooden surfaces from fire. 4000 w. Tech Quar—June, 1900. No. 35209 E.

Horticultural Palace.

The Palaces of Horticulture at the Paris Exposition (Exposition de 1900. Les Palais de l'Horticulture). M. Adémar. A well illustrated description of the Horticultural buildings at the Exposition. 1 plate. 1500 w. Génie Civil—June 23, 1900. No. 35389 D.

Labourers' Dwellings.

The Internal Arrangement of Labourers' Dwellings, particularly of the Kitchen and Heating Apparatus (Die Innere Einrichtung von Arbeiterwohnungen, insbesondere die Gestaltung der Küche und das Zweckmässige Anbringen der Heizanlagen). Prof. H. C. Nussbaum. Abstract of a paper before the Rheinische Verein zur Förderung des Arbeiter-Wohnungswesens, discussing ventilating, heating and kitchen questions. 1200 w. Gesundheits Ing—May 31, 1900. No. 35372 B.

Principles.

Principles of Construction for Architectural Students. E. Wyndham Tarn. Part first discusses foundations, concrete, and piling. 1000 w. Archt, Lond—July 6, 1900. Serial. 1st part. No. 35295 A.

Public Buildings.

The Collaboration of the Architect, the Painter, and the Sculptor. The subject from the view of an architect was discussed by E. W. Mountford; the view of the painter, by W. B. Richmond; and the view of the sculptor, by E. Roscoe Mullins. Three papers and discussions before the Roy. Inst. of Brit. Archts. 9000 w. Builder—June 23, 1900. No. 35095 A.

The Necessity for Official Control over Architecture in Our Towns and Cities. William Emerson. Read before the Roy. Inst. of Brit. Archts. Considers points for and against such control. Also discussion. 8000 w. Builder—June 23, 1900. No. 35094 A.

Rapid Building.

The Financial Importance of Rapid Building. Describes the erection of an 18-story office building in less than fourteen months, and gives reasons for the importance of such rapid construction. 1800 w. Eng Rec—June 30, 1900. No. 35107.

Specifications.

See same title under Mining and Metallurgy, Iron and Steel.

Supporting Power.

The Supporting Power of Rocks and Soils. Hugh Leonard. An account of

experiments made at Calcutta, with tabulated results. 700 w. Jour Roy Inst of Brit Archts—June 16, 1900. No. 35196 B.

HEATING AND VENTILATION.

Blower System.

Ventilation and Heating. W. B. Snow. Read before the Applied Science Soc. of McGill Univ. Illustrates and describes the hot-blast apparatus for combined heating and ventilating, and discusses other systems. 2200 w. Can Engr—July, 1900. Serial. 1st part. No. 35165.

Church.

Ventilation and Heating of a Montclair, N. J., Church. Illustrated description of the arrangement of a church with unusually complete appointments, using both direct and indirect systems of steam heating. The method followed in computing the heating apparatus is explained in some detail. 1500 w. Eng Rec—July 14, 1900. No. 35252.

Gas Heating.

Faulty Gas Stoves and Bath Heaters. A. Gartner. From the *Journal für Gasbeleuchtung*. Summary. Explains the difference between heating and lighting burners, discusses the dangers, and danger indicators. 2400 w. Gas Wld—July 21, 1900. No. 35590 A.

The Efficiency of Gas Heating (Der Nutzeffect der Gasheizung). Erwin Nicolaus. Discussion of the theory, practical results with a variety of gas stoves, and costs; with tables. 3500 w. Gesundheits Ing—June 30, 1900. No. 35373 B.

Gas Heating (Ueber Gasheizung). Erwin Nicolaus. A general discussion of the subject, with table showing amount of products of combustion under various circumstances. Serial. 2 parts. 3200 w. Gesundheits Ing—May 31, June 15, 1900. No. 35370 each B.

Library.

The Providence Public Library. Illustrated description of the general design of a building for 225,000 volumes, with numerous rooms for educational and other purposes; the heating arrangements are explained in detail. 3300 w. Eng Rec—July 21, 1900. No. 35459.

Public Buildings.

Ventilation and Heating of Public Buildings. P. H. Bryce. Read before the Engng. Soc. of the Sch. of Prac. Science, Toronto. Discusses the house air, and means whereby it may serve the requirements of health. 5400 w. Can Archt—July, 1900. No. 35466 C.

PLUMBING AND GAS FITTING.

City Residence.

Plumbing in a Large City House. Illustrated description of unusually elaborate work in a New York residence. 1000 w. Eng Rec—July 28, 1900. No. 35614.

Hospital.

Plumbing in the Manhattan State Hospital. Illustrates and describes the special plumbing features of a large asylum for the insane. 1400 w. Eng Rec—July 7, 1900. No. 35150.

Model Plumbers.

The Model Plumber, from an Architect's Standpoint. O. J. Pierce. Considers the work of the contracting plumber. 3400 w. Dom Engng—July 15, 1900. No. 35465 C.

Public Baths.

Prize Plans for Public Baths (Preisentwürfe für Volksbäder). Franz Loewenstein. An illustrated account of the plans which received prizes at a recent competition instituted by the Deutsche Gesellschaft für Volksbäder, in Berlin. Serial. 2 parts. 1 plate. 3400 w. Gesundheits Ing—May 31, June 15, 1900. No. 35371 each B.

Rain-Baths.

A Plea for Rain-Baths in the Public Schools. Advocates the introduction of rain-baths in the tenement districts, showing why this form is the best. 4500 w. Am Archt—July 14, 1900. Serial. 1st part. No. 35262.

MISCELLANY.

Chimneys.

The Highest Chimney in the World. Louis Fort. Illustrates and describes a chimney in Germany which has a height of 459 feet above the surrounding plane. It is erected on a hill which gives it height equivalent to 656 feet. 900 w. Power—Aug., 1900. No. 35646.

Education.

Architectural Education in the United States of America. Arthur Cates. Reviews various courses available to students. 3400 w. Jour Roy Inst of Brit Archts—June 16, 1900. No. 35197 B.

Engineering Building.

The New Engineering Building of the University of Wisconsin. J. B. Johnson. Description with illustration and plans. 6000 w. Jour W Soc of Engs—June, 1900. No. 35140 D.

Illumination.

Prismatic Lighting for the Illumination of Dark Interiors. Wm. H. Greene. A brief review of the art of prismatic lighting. Ill. 2500 w. Jour Fr Inst—Aug., 1900. No. 35593 D.

Library.

The Stickler Memorial Library, Orange, N. J. Illustrated description of

building for 45,000 volumes. 600 w. Eng Rec—June 30, 1900. No. 35105.

The Congressional Library. An abbreviated description and illustrations of this fine library in Washington, D. C. 1000 w. Archts & Builds' Mag—July, 1900. No. 35120.

See also same title under Heating and Ventilation, above.

Paris Exposition.

A Trip About Paris and the Exposition (Ein Rundgang durch Paris und die Weltausstellung). H. Koestler and P. Kortz. From an address before the Oest. Ing. und Arch. Verein by H. Koestler, giving a general description of the Exposition, with illustrations. 3500 w. Zeitschr d Oest Ing u Arch Ver—July 6, 1900. No. 35346 B.

The Paris Exposition (Die Weltausstellung in Paris). An illustrated general description of the Exposition grounds and buildings. Serial. 1st part. 3500 w. 1 plate. Oest Monatschrift f d Oeff Baudienst—June, 1900. No. 35338 G.

CIVIL ENGINEERING

BRIDGES.

Aqueduct.

The Briare Canal Bridge. Illustrated description of an aqueduct bridge in France, noteworthy for the details of the large metal trough. 900 w. Eng Rec—July 7, 1900. No. 35147.

Bascule.

The Chicago Type of Bascule Bridge. Illustrated description of the general design and special details of a trunnion-type bascule with special brakes, buffers, locking gear and piers. 2300 w. Eng Rec—July 21, 1900. No. 35455.

Cantilever.

A Cantilever-Arch Bridge at the Paris Exposition. Illustrated description of a foot-bridge over the Seine, erected as a cantilever, but acting as an arch when completed, with the roadway as a horizontal tie between the ends. 1200 w. Eng Rec—July 14, 1900. No. 35248.

Drawbridge.

The Passaic River Drawbridge. Illustrated description of the reconstruction and enlargement of the turntable of a plate-girder swing span. 700 w. Eng Rec—June 30, 1900. No. 35102.

Foot-Bridges.

Foot-Bridges which Connect Different Parts of the Exposition at Paris (Exposition de 1900. Passerelles Réunissant entre elles les Différentes Partie de l'Exposition). An illustrated general description of iron and wooden bridges across the Seine and roadways. 1400 w. Génie Civil—July 7, 1900. No. 35395 D.

Lift Bridges.

The Lift or Bascule Type of Movable Bridges. A statement of the relative merits of swing and lift bridges. 1000 w. Eng Rec—July 28, 1900. No. 35607.

Military Bridge.

Military Bridge Over the Oder River (Kriegsbrückenschlag über die Oder). A short, well illustrated description of a trestle-work wooden bridge, 632 meters long, built in 20 days by 50 officers and 1,500 men. 1 plate. 200 w. Wiener Bauindustrie Zeitung—May 24, 1900. No. 35366 D.

Old Rails.

Use of Old Rails in Overhead Bridges, N. S. W. Govt. Rys. Detailed drawings and description of these bridges, showing the practicability of utilizing old rails for this purpose. 1000 w. Ry & Engng Rev—July 7, 1900. No. 35166.

Paris Exhibition.

The Exhibit of Typical American Bridges at the Paris Exposition. George L. Fowler. Engravings of ten drawings illustrating typical designs of some of the notable railway bridges, with descriptions. 4000 w. Eng News—July 5, 1900. No. 35186.

Siberian Railway.

Building the Bridge Across the Yenisei. Illustrates and describes the method of using the local wood for the caissons of the bridge pillars. 1200 w. Engr, Lond—July 6, 1900. No. 35413 A.

Thomas Steel.

The Steel Question in Austria (Die Flusseisenfrage in Oesterreich). Prof. Mehrtens. A review of the production of Bessemer, Thomas and Martin steel in Austria, and a discussion of the report of the bridge-material committee of the *Oesterr. Ingenieur und Architekten Verein* on the admissibility of Thomas steel in bridge construction. 2500 w. Zeitschr d Ver Deutscher Ing—July 7, 1900. No. 35308 D.

Viaduct.

Riverside Drive Viaduct, New York. Illustrations and brief description of the interesting features of a viaduct being constructed to connect Riverside Drive with the driveways further north. 1200 w. Sci Am—July 21, 1900. No. 35423.

The Design and Cost of Viaducts

(Ueber Anlage und Kosten der Bahnviadukte). Rob. Moser. A comparison of the cost of stone and iron viaducts, to the advantage of the former; with curves and tables. 1800 w. Schweiz Bauzeitung —June 30, 1900. No. 35364 B.

The Gokteik Gorge Viaduct. Illustrations and brief description of the bridge works on the Mandalay Ry., India. 900 w. Ind & East Engr—June, 1900. No. 35496 B.

CONSTRUCTION.

Concrete.

Concrete Masonry Construction at Low Temperatures. A statement of the conditions which must be filled to ensure good work during freezing weather. 900 w. Eng Rec—July 21, 1900. No. 35453.

Macadam.

The Thickness of Macadam Material. Illustrates the difference between old and modern roads, and discusses the thickness required to resist the pressure from traffic. 800 w. Sci Am Sup—July 21, 1900. No. 35425.

Monier Constructions.

Monier Constructions. E. Lee Heidenreich. Explains the general construction, its principal qualities, and illustrates where it has been successfully applied. Also discussion. 10000 w. Jour W Soc of Engs—June, 1900. No. 35142 D.

Piers.

The Failure and Repair of the Piers of the Aqueduct Bridge, Washington, D. C. L. R. Grabill. Illustrated description of the damage and methods adopted in making repairs. 3800 w. Eng News—July 26, 1900. No. 35533.

Roads.

Road Making and Road Metal. Considers the methods of Telford and MacAdam, and the materials used. 1900 w. Auto Jour—July, 1900. No. 35494 A.

Road Drainage. Arthur Newhall Johnson. Extract from an article in the report of the Maryland Geol. Survey for 1899. Illustrated description of methods. 2200 w. Brick—Aug. 1, 1900. No. 35701.

Roads for Mining Purposes. C. C. Longridge. Discusses the principles and problems of construction of mining roads, routes, gradients, drainage, etc. 3500 w. Engng—July 13, 1900. No. 35500 A.

Simplon Tunnel.

The Construction of the Simplon Tunnel (Der Bau des Simplon Tunnels). C. J. Wagner. A full report of the progress made on this great undertaking to the end of 1899, with maps. 6500 w. Zeitschr d Oest Ing u Arch Ver—May 25, 1900. No. 35341 B.

The Simplon Tunnel. Illustrated description of the methods adopted at each end of this tunnel, and a statement of work accomplished up to 1900. 3000 w. Eng Rec—July 7, 1900. No. 35146.

Stresses.

The Bending Stresses on Flat Rectangular Concrete Floors. Frank Cows. A criticism of paper by W. Dunn. 1800 w. Jour Roy Inst of Brit Archts—June 30, 1900. No. 35525 B.

Superstructure.

Concrete Pier Superstructure for the New Ship Canal Entrance to Duluth Harbor, Minn. Illustrates the revised designs and describes the general construction. 3500 w. Eng News—July 26, 1900. No. 35534.

Tunnel.

Argo or Newhouse Tunnel. Arthur Lakes. The purpose for which it is being driven and the method of driving. Ill. 3800 w. Mines & Min—Aug., 1900. No. 35686 C.

Tunneling.

Tunneling with Shields. Illustrated extracts from paper of H. H. Dalrymple-Hay, before Inst. of C. E., describing the different methods of shield tunneling on the Waterloo and City Railway, particular attention being given to methods of timbering in advance of the shield in water-bearing strata. 5500 w. Eng Rec —July 14, 1900. No. 35250.

The Great Alpine Tunnels. Francis Fox. A discourse delivered at the Royal Inst. Considers tunneling and the remarkable instances of the past, discussing in detail the Mont Cenis, St. Gothard and Simplon tunnels. Ill. 4000 w. Nature—July 19, 1900. No. 35606 A.

Wharf.

A Large Steel Pier Shed. Illustrates and describes the design and methods of construction of the 736 x 120-ft. pier-shed of the White Star Line in New York, one of the last to be built prior to the fire on the piers of the North German Lloyd line in Hoboken. 2500 w. Eng Rec—July 28, 1900. No. 35613.

Iron-Ore Loading Docks. Waldon Fawcett. An illustrated account of construction under way which will make a holding capacity of 800,000 tons at the Great Lakes. 2000 w. Am Mfr & Ir Wld —July 19, 1900. No. 35472.

Fires on Freight Piers. Editorial discussion of the construction of freight piers to diminish fire hazards. 1000 w. Eng Rec—July 14, 1900. No. 35244.

HYDRAULIC AND WATER SUPPLY.

Austin Dam.

Concerning the Austin Dam. R. D. Parker. Illustrated reports from various sources on the results of soundings at low water to determine the manner of

failure of a 67-ft. masonry dam; these point to undermining as the cause. 1700 w. Eng Rec—June 30, 1900. No. 35101.

The Austin Dam. Report by H. B. Patterson, in charge of this 60-ft. masonry dam, describing the reason for its recent failure. 900 w. Eng Rec—July 28, 1900. No. 35610.

Breakwater.

The Reaction Breakwater as Proposed for the Opening of the South-West Pass of the Mississippi River. Lewis M. Haupt. An explanation of the problem to be solved and the plans proposed. Ill. 5000 w. Jour Fr Inst—July, 1900. No. 35159 D.

Canal Haulage.

See Electrical Engineering, Power Applications.

Canalization.

The Work of the Commission for Canalizing the Moldau and Elbe Rivers in Bohemia in 1899 (Die Thätigkeit der Commission für die Canalisierung des Moldau und Elbeflusses in Böhmen im Jahre 1899). An illustrated account of the improvements in progress on these rivers. 1800 w. Oest Monatschrift f d Oeff Baudienst—June, 1900. No. 35339 G.

Canals.

The Elbe-Trave Canal (Der Elbe-Trave Kanal). A full and very well illustrated account of this 42-mile canal between Lübeck and Lauenburg on the Elbe, with its locks and the bridges crossing it. Compiled from official sources. 12000 w. 2 plates. Zeitschr d Ver Deutscher Ing—June 16, 1900. No. 35300 D.

The Rhine-Elbe Canal Project. Information concerning a great project for increasing the traffic facilities in Germany. 4400 w. Engng—June 22, 1900. No. 35112 A.

Docks.

Naval Docks of the United States. Illustrated detailed description of the machine being built for the government at Baltimore. It is large enough and strong enough to lift the Oceanic. 2000 w. Am Mfr & Ir Wld—June 28, 1900. No. 35098.

The Dockization of the Avon. Review of the report to the Dockization Committee of the City of Bristol, Eng., in reference to a gigantic scheme to provide necessary accommodation for modern vessels. 2200 w. Transport—June 22, 1900. No. 35093 A.

See also Wharf, under Civil Engineering Construction.

Dredges.

See Marine and Naval Engineering.

Hydrology.

The Kimberly & Clark Paper Mill at Quinnesec Falls. Illustrated description of the hydrology of a river-shed utilized by a large paper-mill in Wisconsin. 2800 w. Eng Rec—June 30, 1900. Serial. 1st part. No. 35106.

Irrigation.

Irrigation Works in the Jeypore State, Rajputana, India. Charles Egremont Stotherd. A short description of some of the works, showing the different methods adopted, and the results attained. Ill. 4400 w. Ind & East Engr—June, 1900. No. 35497 B.

Isthmian Canal.

The Topography of the Nicaragua Canal Route, and the Plans and Estimated Cost of Constructing the Canal. E. S. Wheeler. Presents the principal results of the Nicaragua Canal Commission's report, without data or discussion, giving a map showing the topography of the region. 7200 w. Eng News—July 12, 1900. No. 35254.

Kutter Formula.

Hydraulic Diagrams. Letter from T. Horton and editorial reply on the best methods of plotting the Kutter formula. 2000 w. Eng Rec—July 28, 1900. No. 35615.

Meters.

Practical Experience with Water Meters at Lexington, Ky. S. A. Charles. Read before the Am. Water Works Assn. Considers difficulties real and imaginary in the use of meters. 2000 w. Fire & Water—July 7, 1900. No. 35157.

Nicaragua.

See Isthmian Canal.

Pipes.

Wooden Water-Supply Piping. Illustrated description of pipe constructed on an estate in North Wales, for bringing water to a farm for driving a mill and for pumping a supply for nine different farms. 1300 w. Engng—July 20, 1900. No. 35571 A.

Rating.

The Rating of Water Undertakings. F. J. Bancroft. Read before the British Assn. of Water-Works Engs. An explanation and discussion of British practice. 11000 w. Jour Gas Lgt—July 3, 1900. No. 35274 A.

Reservoirs.

The Staines Reservoirs Scheme. On the progress of the work of building storage reservoirs in the valley of the Thames to furnish London with additional supply of water. 1600 w. Jour Gas Lgt—July 3, 1900. No. 35273 A.

The Grand Rapids Reservoir Accident. Lewis D. Cutcheon. Illustrated description of the washout of the earth bank of a 6,000,000 gallon reservoir, due to lack of overflow provision. 1200 w. Eng Rec—July 14, 1900. No. 35246.

The Failure of the Distributing Reservoir of the Water-Works of Grand Rapids, Mich. An illustrated account of the accident, believed to be due to overfilling the reservoir. 1200 w. Eng News—July 12, 1900. No. 35255.

Siphons.

Siphons. Thomas McKeown. Notes on the history of siphons, and their use in water supplies and sewage transfer. Discussion. 2200 w. Jour Assn of Engng Socs—June, 1900. No. 35400 C.

Water Pipes.

20-inch Steel Pipe Substituted for 30-in. Cast-Iron Pipe at a Railway Crossing in Boston. H. F. Winslow. Illustrates and describes a change made necessary by a new railway connection which must pass under the street. 350 w. Eng News—July 26, 1900. No. 35532.

Water Power.

See Mechanical Engineering, Hydraulics.

Water Supply.

Impure and Unwholesome Water and Its Experimental Improvement. Floyd Davis. Discusses the improvement due to the education of the common people and their better understanding of the danger, calling attention to some organisms that are proof of unwholesomeness. 1800 w. Munic Engng—Aug., 1900. No. 35-655 C.

New Jersey Forests and Their Relation to Water Supply. C. C. Vermeule. Read before the Am. Forestry Assn. Claims that run-off is not affected as to total quantity to any appreciable degree by forests, but depends on temperature and rainfall. Also editorial giving formula based on the conditions observed in many catchment areas. 4000 w. Eng Rec—July 7, 1900. No. 35149.

Notes on the Geology of the Sites of the Proposed Dams in the Valleys of the Housatonic and Ten-Mile Rivers. W. O. Crosby. Describes the geology of a region investigated in view of securing water for the supply of Greater New York. 3000 w. Tech Quar—June, 1900. No. 35208 E.

Outline of the Geology of Long Island in its Relation to the Public Water Supplies. W. O. Crosby. Sketch of that part of Long Island that has a bearing on the supply for Greater New York. 7500 w. Tech Quar—June, 1900. No. 35207 E.

The New York Water Supply. A statement of the imminent danger of a water famine in five years in New York, and recommendations of J. R. Freeman for obtaining new supplies. 1600 w. Eng Rec—June 30, 1900. No. 35100.

Water Supply in Various Cities. Interesting tables compiled from information concerning the water supply in cities of America, England and Australia for the year 1898. 600 w. Engr, Lond—June 22, 1900. No. 35111 A.

Water Tower.

The City Water Works in the Favoriten District of Vienna (Das Städtische Wasserwerk in Favoriten). A well illustrated description of a highly ornamental water tower and pumping station. 2 plates. 800 w. Wiener Bauindustrie Zeitung—June 21, 1900. No. 35367 D.

New Water Tower at Murphysboro, Ill. Illustrated detailed description of an elevated tank with spherical bottom, encased in wood and provided with horizontal stiffening girders. 1300 w. Eng Rec—July 7, 1900. No. 35148.

Water Waste.

The Relationship between Cost of Water Wasted and Cost of Detection and Prevention of Waste. A. J. Jenkins. Abstract of paper read before the British Assn. of Water-Works Engs., discussing this subject. Also general discussion. 5000 w. Jour Gas Lgt—July 10, 1900. No. 35484 A.

Waterways.

Two Hundred Million. Considers the final report of the deep waterways commission, dealing with routes for a ship canal within United States territory from the Great Lakes to the Atlantic. 2000 w. Marine Rev—July 12, 1900. No. 35236.

Water Works.

Construction of the Binghamton Suction Well. Illustrated description of a pump well 33½ ft. in diameter and 24 ft. deep, which was sunk by means of a pneumatic caisson. 600 w. Eng Rec—July 28, 1900. No. 35612.

The Jersey City Water-Works. Illustrated description of the 50,000,000-gal. gravity works now under construction, which include a masonry dam over 100 ft. high, an aqueduct of riveted steel pipe and masonry and a long tunnel. 4000 w. Eng Rec—July 21, 1900. No. 35458.

MATERIALS.

Cement.

Conditions in Portland Cement Kilns. Edward Duryea. Illustrates and describes the form of rotary kiln recently used by the writer and a statement of its advantages. 1200 w. Eng News—Aug. 2, 1900. No. 35693.

Model Specifications and Tests for Cement. A copy of the specifications for the city of Pittsburg for the construction of bridges, streets and sidewalks. 2700 w. Munic Engng—July, 1900. No. 35134 C.

Portland Cement. Concerning cement manufacture, the materials and treatment and system of testing. 4300 w. Builder—July 14, 1900. No. 35495 A.

The First Manufacturers of Portland Cement by the Direct Rotary Kiln Process. E. Duryee. An account of work at Rondout, N. Y., and at Montezuma, N. Y. 700 w. Eng News—July 26, 1900. No. 35536.

The Development and Future Prospects of Portland Cement Manufacture in America. Considers the recent and rapid growth of this industry in the United States, to what it is due, and the probability of its enduring. 3500 w. Eng News—July 26, 1900. No. 35535.

The Virginia Portland Cement Company's Works. Watson Vredenburgh, Jr. Illustrated description of a plant at Craigsville, W. Va., in which both shafting and electricity are employed to transmit power. The course of the materials from the quarries to the bags and barrels ready for shipment is followed in detail. 2700 w. Eng Rec—July 28, 1900. No. 35609.

Concrete.

Economical Concrete Mixing. A. McLean Parker. Illustrated description of plant for mixing concrete in a very confined situation. 600 w. Eng Rec—June 30, 1900. No. 35103.

Roads.

Qualities of Good Road-Metals. Harry Fielding Reid. From the Maryland Geological Survey. On the methods of selecting and testing road material. 2800 w. Stone—July, 1900. No. 35450 C.

Specifications.

See same title under Mining and Metallurgy, Iron and Steel.

Timber.

Preservation of Timber. Written and oral discussion of Mr. Chanute's paper on this subject. 5000 w. Jour W Soc of Engs—June, 1900. No. 35141 D.

MEASUREMENT.

Levelling Rod.

A Compensated Rod for Precise Levelling (Ueber eine Kompensationslatte beim Präcisions-nivellement). Dr. J. Hilfiker. An illustrated description of a wood, brass and iron levelling rod, compensated for temperature changes. Serial. 2 parts. 3000 w. Schweiz Bauzeitung—June 16, 23, 1900. No. 35362 each B.

Surveying.

A Beam Compass for Plotting Surveys. C. Gregorie. Describes an instrument with which measurements of one link and less can be accurately plotted on plans of two chain and 1-2500 ordnance scale. 900 w. Col Guard—July 6, 1900. No. 35286 A.

Tape Tension.

A Surveying Tape Tension Equalizer (Der Messband-Spanner. Ein Markscheiderisches Hilfsinstrumentchen). M. Przyborski. An illustrated description of a spring hook for holding the end of a surveying tape so as to stretch it equally whenever in use. 400 w. Oest Zeitschr f Berg u Hüttenwesen—June 16, 1900. No. 35356 B.

MUNICIPAL.

Beautiful Cities.

I. The Ideal City. Halsey Recardo. II. Streets and Bridges. Considered in Connection with Our Unideal City. W. D. Caröe. III. The Sculptor's Point of View. T. Stirling Lee. Papers and discussion before the Royal Inst. of Brit. Archts. 12000 w. Builder—June 23, 1900. No. 35096 A.

Fire Alarm.

See Electrical Engineering, Communication.

Garbage.

See Refuse, below.

Macadam Pavement.

See Civil Engineering, Construction.

Parks.

Parks and Boulevards. A. C. Schrader. Suggestions for their construction and maintenance. General discussion. 12400 w. Jour W Soc of Engs—June, 1900. No. 35139 D.

Pavements.

Pavements in Switzerland. Report of experiments made in Basle with wood pavements, including American pitch pine. 700 w. U. S. Cons Repts, No. 772—July 5, 1900. No. 35138 D.

Public Buildings.

See Architecture and Building.

Rapid Transit.

See Street and Electric Tramways.

Refuse.

Garbage Reduction at Columbus, O. Describes the manner of collecting, and treatment at the reduction works. 2200 w. Eng News—July 19, 1900. No. 35440.

Review of Different Methods of Treating Refuse (Considérations sur les Divers Modes de Traitement des Ordures Ménagères). Ach. Livache. A general discussion of the various economical methods of garbage disposal, with many references to American and British practice. 7000 w. Bull de la Soc d'Encour—May 31, 1900. No. 35565 G.

Roads.

See Civil Engineering, Construction.

Sanitation.

Some Phases of Public Sanitation. E. C. Gardner. Calls attention to practices in cities and towns that cause illness and discomfort. 5000 w. Am Archt—July 28, 1900. No. 35580.

Sewage.

The Bacterial Treatment of Sewage in England. William Easby, Jr. Considers the operation of the bacterial systems and the results obtained by them. Illustrations and discussion. 12800 w. Pro Engs' Club of Phila—July, 1900. No. 35275 D.

Sewers.

Sewer Maintenance. W. C. Parmley. Discusses what is an adequate and efficient system of sewerage, and its maintenance, after being put in operation. 5500 w. Jour Assn of Engng Socs—June, 1900. No. 35403 C.

MISCELLANY.

Address.

Presidential Address, American Society of Civil Engineers. John Findley Wallace. London address on the status of the engineering profession. 3200 w. Eng Rec—July 14, 1900. No. 35249.

China.

See Railways Affairs, New Projects.

Contractor's Rights.

The Rochester Conduit Litigation. A review of a suit lasting eight years, just settled by the U. S. Supreme Court in a decision refusing to consider a surety on a bid, or the bidder, bound by the terms of a tender when the bidder's representative announces as soon as his bid has been read and before that of another bidder has been opened, that certain figures in his tender were errors. 2800 w. Eng Rec—July 28, 1900. No. 35608.

Cycleway.

A California Cycleway. Charles Frederick Holder. Illustrates and describes an interesting construction between Pasadena and Los Angeles, for bicycles and motorcycles. 1500 w. Sci Am—July 14, 1900. No. 35239.

Education.

Doctors of Engineering. A statement of the new Prussian regulations authorizing technical schools to grant a doctor's degree in engineering equivalent to one in philosophy. 800 w. Eng Rec—July 14, 1900. No. 35245.

Industrial Education in America. Report of a committee of the Soc. for the Promotion of Engng. Ed., read at N. Y. meeting. 7500 w. Eng News—July 12, 1900. No. 35257.

Labor.

Trusts and Their Relation to the Engineer. Charles H. Wright. Discusses the effect of the trusts on labor, the meaning of the term, the advantages, etc. 3800 w. Jour Assn of Engng Socs—June, 1900. No. 35401 C.

Porto Rico.

The Material Deveyopment of the Island of Porto Rico. Albert W. Buel. Suggestion of immediate needs—chiefly good roads—and warning against undue expectations until education and emulation have wakened the people to a higher plane of living, with its larger demands. Finely illustrated. 3600 w. The Engineering Magazine—Aug., 1900. No. 35-634 B.

Societies.

The Largest Engineering Society. Describes the organization and work of the Society of German Engineers, which had 13,928 members at the close of 1899. 1100 w. Eng Rec—July 21, 1900. No. 35454.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

A Practical Transmitter Using the Sine Wave for Cable Telegraphy; and Measurements with Alternating Currents upon an Atlantic Cable. Albert C. Crehore and George O. Squier. Full paper. Describes a method of utilizing the sine wave for cable signaling, and a practical cable transmitter employing these principles. Ill. 8000 w. Trans Am Inst of Elec Engs—May, 1900. No. 35-231 D.

The Projected Cable Line to the Philippines. Chandler Hale. Discusses the feasibility of a trans-Pacific cable owned by the government, and the Alaskan route as compared with the southern route from San Francisco to Manila. 2700 w. N Am Rev—July, 1900. No. 35156 D.

Duplex.

Duplex and Diplex Transmission by Means of Electric Waves (Transmissions Duplex et Diplex par Ondes Electriques). Albert Turpain. A short account of a system using both continuous currents and electric waves. 500 w. Comptes Rendus—May 14, 1900. No. 35398 D.

Fire Alarm.

What Are the Requirements of a Fire Alarm System in Medium-Size and Large Cities (Welche Anforderungen sind an eine Feuermelde-Einrichtung in Mittleren und Grösseren Städten zu Stellen)? C. v. Moltke. A paper read before the Verband Deutscher Elektrotechniker containing a general discussion of the subject. 1100 w. Elektrotech Zeitschr—June 21, 1900. No. 35312 B.

Graphophone.

The Graphophone Grand. Report of committee of the Franklin Inst. on the invention of Thos. H. Macdonald, and embracing a general history of sound-recording and reproducing devices, with a supplement by Philip Mauro. Ill. 6900 w. Jour Fr Inst—July, 1900. No. 35160 D.

Harmonic Telegraph.

The Mercadier Harmonic Telegraph System (Télégraphe Harmonique de M. Mercadier). A. Fleury. An illustrated description of the system, which is based on the harmonic vibration of tuning forks, with an account of a telephonic relay. 2200 w. Electrician—June 9, 1900. No. 35557 B.

Multiplex.

The Mercadier Multiplex Telegraph System (Télégraphie Multiple Réversible ou Multiplex Système E. Mercadier). G. Briand. An illustrated description of a system which works by the inductive action of undulatory currents. 1400 w. Génie Civil—June 16, 1900. No. 35388 D.

Space Telegraphy.

Arrangement Intended to Prevent the Interception of Despatches in Wireless Telegraphy. D. Tommasi. An illustrated description of the arrangement. 800 w. Elec Rev, Lond—July 13, 1900. No. 35476 A.

Syntony in Wireless Telegraphy (Sur la Syntonie dans la Télégraphie sans Fil). A. Blondel. A description of a system of selective signalling by means of a telephone and resonating circuits. 700 w. Comptes Rendus—May 21, 1900. No. 35550 D.

Wireless Telegraphy Experiments with a Free Balloon (Experiences de Télégraphie sans Fil en Ballon Libre). J. Vallot, J. and L. Lecarme. The receiver was on the balloon and signals were received at a height of 800 meters and at a distance from the transmitter of 6 kilometers. 500 w. Comptes Rendus—May 14, 1900. No. 35399 D.

The Maximum Sensitiveness of Coherers in Practical Use in Wireless Telegraphy (Sur la Sensibilité Maxima des Cohéreurs Employés Pratiquement dans la Télégraphie sans Fils). A. Blondel and G. Dobkévitch. A short account of a method of controlling the sensitiveness of a coherer by altering the pressure on the filings by increasing their amount. 600 w. Comptes Rendus—April 23, 1900. No. 35397 D.

Telegrams.

Six Penny Telegrams—Why They Do Not Pay. J. Henniker Heaton. Discusses the British telegraph service. 4200 w. Nineteenth Cent—July, 1900. No. 35449 D.

Telegraphone.

The Paulsen Telegraphone (Le Télégraphone de M. Paulsen). M. Aliamet. An illustrated description of this apparatus, in which a magnetic record is made on a steel wire or tape. 1000 w. Electrician—June 2, 1900. No. 35554 B.

The Telegraphone (Das Telegraphon). Dr. Thomae. A short illustrated description of the Paulsen magneto-telephonograph, in which an electromagnet, in circuit with a microphone, makes a magnetic record on a steel wire or tape. 1200 w. Zeitschr d Ver Deutscher Ing—June 30, 1900. No. 35304 D.

Telephone.

The Railway and the Telephone. Henry W. Pope. Read before the Ry. Telegraph Supts.' Assn., at Detroit, Mich. The possibilities of the telephone, and its adaptability to railroad service. 3500 w. St. Louis Ry Club—July 13, 1900. No. 35452.

The Use of the Telephone in the Working of Railway Traffic. Thomas Ireland. Prepared for the International Ry. Cong. Discusses its usefulness and limits, and considers it an important auxiliary. 2000 w. Transport—July 13, 1900. No. 35481 A.

Burgunder Telephone System (Transmetteurs et Recépteurs Telephoniques Système Burgunder). L. Montillot. An illustrated description of transmitter and receiver and other details of the system. 1000 w. Electricien—June 23, 1900. No. 35560 B.

A Curious Telephone Experiment (Une Curieuse Expérience Téléphonique). Em. Pièrard. An illustrated description of experiments in which sounds were produced by currents due to the volta contact effect of metals. 1400 w. Electricien—May 19, 1900. No. 35551 B.

Ducousso Telephone Transmitters and Receivers (Transmetteurs et Recepteurs Téléphoniques Système Ducousso). L. Montillot. An illustrated description of the system. The transmitters are granular carbon microphones; the receiver magnet is circular. 800 w. Electricien—June 2, 1900. No. 35555 B.

DISTRIBUTION.

Alternator.

A String Alternator. K. Honda and S. Shimizu. Describes a modified form of Pupin's interrupter, used as an alternator. 600 w. Am Jour of Sci—July, 1900. No. 35136 D.

Arc Lamps.

Arc Lamp Distribution. Alton D. Adams. A discussion of the systems of arc lamp operation. 2500 w. Elec Rev, N. Y.—July 25, 1900. No. 35542.

Boosters.

Direct Current-Boosters. Claude W. Hill. Illustrates and describes a track feeder booster with its motor. 700 w. Elec Rev, Lond—July 6, 1900. No. 35-293 A.

Converting-Machinery.

On Converting-Machinery for Tramway Sub-Stations. A. C. Eborall. Discusses some fundamental considerations relating to rotary converters and motor-generators for use in sub-stations. Considers that in the majority of cases motor-generator equipments will give the best results in actual working. 2000 w. Tram & Ry Wld—July 5, 1900. No. 35490 A.

Distributing Systems.

The Distribution of Electricity. G. Wilkinson. Abstract of a paper read before the Munic. Elec. Assn., England. Also editorial review. Calls attention to faults in systems in use. 2500 w. Elec Rev, Lond—July 6, 1900. No. 35290 A.

Earth Potential.

On the Maintenance of Certain Portions of Distributing Systems at Earth Potential. C. H. Wordingham. Read at Cardiff convention of Munic. Elec. Assn. Considers earth connections in various systems of transmission, and the manner the currents return through the earth, and whether it is best for any supply to be connected to earth. 5000 w. Elec Eng, Lond—July 20, 1900. No. 35585 A.

Induction.

Alternating-Current Induction Motors. A. C. Eborall. Read before the Inst. of Elec, Engs. Discusses points connected with the construction, design and performance of modern single and polyphase induction motors, and considers some recent developments. Ill. 3000 w. Elec Eng, Lond—July 20, 1900. Serial. 1st part. No. 35583 A.

Insulation.

Substitutes for India Rubber and Gutta Percha for Electrical Purposes. From the *Electro-Chemical Review.* Concerning compounds that may be used as substitutes for many uses. 1200 w. Am Gas Lgt Jour—July 9, 1900. No. 35174.

Losses.

The Reduction of Light-Load Losses in Alternating Supply Works. Horace Boot. Read at Huddersfield convention of the Munic. Elec. Assn. Considers works losses and distribution losses, and means of reducing them. Discussion. 4800 w. Elec Eng, Lond—July 6, 1900. No. 35408 A.

Polyphase.

The Polyphase Power Distributing System of the Deering Harvester Company. Illustrated description of an isolated plant unique on account of its size and its use of induction motors on a large scale. 5000 w. Am Elect'n—Aug., 1900. No. 35659.

Wire Protection.

The Protection of Telegraph and Telephone Wires in Connection with Overhead Traction. R. C. Quin. Read at Cardiff convention of Munic. Elec. Assn. Briefly considers the systems of protection in use. 1300 w. Elec Eng, Lond—July 20, 1900. No. 35587 A.

Wiring.

Free Wiring. E. E. Hoadley. A copy of the scheme worked out for the free wiring of the city of Worcester, Eng. 3500 w. Elect'n, Lond—June 22, 1900. No. 35091 A.

ELECTRO-CHEMISTRY.

Accumulators.

The Manufacture of Electric Accumulators. The importance of purity of materials and methods of testing. 2000 w. Auto Jour—July, 1900. No. 35492 A.

Gas Polarization in Lead Accumulators (Ueber die Gas-polarisation im Bleiakkumulator). Dr. Strasser and Dr. Gahl. An article, giving the results of experiments with lead-antimony negative plates of various composition. 1000 w. Zeitschr f Elektrochemie—July 5, 1900. No. 35-375 G.

Progress in the Development of Secondary Batteries in the Last Twenty-five Years (Fortschritte in der Entwickelung der Sekundärbatterien in den Letzten 25 Jahren). An historical review of slow but steady progress. Serial. 2 parts. 3500 w. Elektrochemische Zeitschr—June, July, 1900. No. 35377 each G.

Investigations of Battery Plates in Need of Repairs (Untersuchungen über Reparaturbedürftige Batterieplatten). J. K. Pumpelly. Photographs and descriptions of storage battery plates which had been in use for two months on motor vehicles in the streets of Chicago. 400 w. Elektrochemische Zeitschr—July, 1900. No. 35378 G.

Alkalies.

Anodes for Electrolytic Alkali Processes. A. T. Weightman. A statement of the difficulties met and remedies found. 2700 w. Eng & Min Jour—Aug. 4, 1900. No. 35699.

Calcium Carbide.

On Discontinuous and Continuous Carbide Furnaces (Ueber Diskontinuierliche und Kontinuierliche Carbidöfen). Dr. O. Fröhlich. A comparison and illustrated description of various forms of electric furnaces for producing calcium carbide. 4500 w. Zeitschr f Elektrochemie—July 5, 1900. No. 35374 G.

Electrolysis.

Electrolysis Without Electrodes (Elektrolyse ohne Elektroden). Rud. v. Heuser. An illustrated description of an apparatus in which the electrolyte circulates between magnet poles and so has currents induced in it. 2000 w. Elektrochemische Zeitschr—June, 1900. No. 35376 G.

See also same heading under Street and Electric Tramways.

ELECTRO-PHYSICS.

Cathode Rays.

On the Energy of the Cathode Rays. W. G. Cady. An investigation carried out at the Physical Inst. of the Univ. at Berlin. Ill. 3500 w. Am Jour of Sci—July, 1900. No. 35135 D.

Induction.

Improved Induction Coils. James Asher. Describes several simple methods of suppressing sparking without employing a condenser. 1500 w. W Elect'n—July 21, 1900. No. 35473.

Interrupter.

Alternating-Current Work with the Wehnelt Interrupter. Benjamin F. Bailey. Report of investigations made at the Univ. of Mich. 3300 w. Elec Wld & Engr—July 14, 1900. No. 35233.

Spectroscopic Observations with the Wehnelt Interrupter (Spektroskopische Beobachtungen am Wehnelt-Unterbrecher). Edm. Hoppe. A description of an apparatus for the steady observation of the spectra of metals and metallic salts in the Wehnelt spark. 1500 w. Elektrotech Zeitschr—June 21, 1900. No. 35311 B.

Magnetism.

The Action of Light on Magnetism. Joseph Hall Hart. An account of experimental investigations, with conclusions drawn from the results obtained. 2800 w. Am Jour of Sci—July, 1900. No. 35137 D.

Radiation.

The Best Known Theories of Röntgen Rays (Die Bekanntesten Theorien über das Wesen der Röntgenstrahlen). Dr. H. Schenkel. A general review of Röntgen ray theories. Serial. 2 parts. 3200 w. Elektrizität—May 26, June 9, 1900. No. 35385 each C.

Radio-Conductors.

The Increase in Resistance of Some Radio-Conductors (Accroissements de Résistance des Radioconducteurs). Ed. Branly. A short account of some experiments tending to confirm the opinion that the phenomenon is due to the physical state of the insulating layers between the conducting particles. 700 w. Comptes Rendus—April 17, 1900. No. 35396 D.

GENERATING STATIONS.

Central Station.

The Blackheath and Greenwich Electric Light Company's Central Station. Illustrates and describes a station for the supply of current for lighting and power in England. 2100 w. Engr, Lond—July 20, 1900. Serial. 1st part. No. 35628 A.

Dynamo.

Siemens-Halske Dynamo and Borsig Engine at the Paris Exposition (Groupe Electrogène, Machine à Vapeur Borsig et Alternateur Siemens et Halske). F. Loppé. An illustrated description of this 2,000-kilowatt polyphase generator, with characteristic curves. 2 plates. 1600 w. Electricien—July 7, 1900. No. 35562 B.

Siemens-Halske Dynamo and Borsig Engine of 2,500 Horse-Power at the Paris Exposition (Exposition de 1900. Groupe Electrogène de 2,500 Chevaux Borsig et Siemens et Halske). Ch. Dantin. A well illustrated description of this great generating unit in the German section of Machinery Hall. 1 plate. 1800 w. Génie Civil—June 16, 1900. No. 35387 D.

Rotary-and Alternating Current Generator of the Helios Company (Dreh-und Wechselstromgenerator des Helios, Elektricitäts-A.-G.). An illustrated description of this large dynamo in the German section of Machinery Hall at the Paris Exposition. 1600 w. Elektrotech Zeitschr—June 21, 1900. No. 35309 B.

Schuckert Direct Current and Rotary Current Generators at the Paris Exposition (Die Elektricität auf der Pariser Weltausstellung. Gleichstrom-und Drehstrom-Generatoren der Elektrizitäts—A. G. vorm. Schuckert & Co. in Nürnberg). An illustrated description of two large Schuckert dynamos directly coupled to a 2,200 horse-power engine. 500 w. Elektrotech Zeitschr—July 12, 1900. No. 35320 B.

The 4,000 Horse-Power Rotary Current Dynamo of the Allgemeine Elektricitäts Gesellschaft at the Paris Exposition (Die 4,000 Pferdige Drehstrom-Dynamomaschine der A. E. G. auf der Weltausstellung in Paris). A short description, with photographic illustrations. 400 w. Ill Zeitschr f Klein u Strassenbahnen—July 1, 1900. No. 35384 C.

Dynamo Design.

The Designing and Testing of Dynamos and Motors (Beiträge zur Berechnung und Beurtheilung von Dynamomaschinen und Motoren). Dr. F. Niethammer. A discussion, partly mathematical, of the design of dynamos and motors, with diagrams. Serial. 2 parts. 3200 w. Elektrotech Zeitschr—June 28, July 5, 1900. No. 35314 each B.

Germany.

Review of German Central Station Sta-

tistics (Rundschau). Editorial review of the statistics of the public central stations in Germany on March 1, 1900. 2800 w. Elektrotech Zeitschr—July 5, 1900. No. 35317 B.

German Central Station Statistics (Statistik der Elektricitätswerke in Deutschland nach dem Stande vom 1 März, 1900). General statistical tables of all the public central stations in Germany, either in operation or in course of construction on March 1, 1900. 10000 w. Elektrotech Zeitschr—July 5, 1900. No. 35316 B.

Gloucester.

Gloucester Electricity Works. Illustrated detailed description of plant. 4500 w. Elec Eng, Lond—July 20, 1900. No. 35582 A.

Paris Exposition.

The Central Station for Power and Light at the Paris Exposition (Die Pariser Weltausstellung III. Die Kraft-und Lichtcentrale). An illustrated description of some of the features of Machinery Hall on the Champ de Mars. 3000 w. Stahl und Eisen—May 15, 1900. No. 35326 D.

Power Plant.

The Power Plant of the New York Factory of the Western Electric Company. An illustrated description of a fine isolated plant, probably the largest delivering its output to one building in the world. 2500 w. Am Elect'n—July, 1900. No. 35179.

Power-Station Design.

Some General Conditions Governing Power Station Design. Philip Dawson. Read before the Tramways and Light Rys. Assn. Considers the question from the economical point of view, calling attention to the differences in a station designed for lighting, and one designed for traction. 2000 w. Elec Rev, Lond—July 6, 1900. No. 35292 A.

Construction of a Large Power-House Building. Illustrated description of the methods followed by the builders of the 70,000 H.-P. station of the Metropolitan Street Railway Co., New York. 2000 w. Eng Rec—July 28, 1900. No. 35611.

Power Station of the Northwestern Elevated Railroad, Chicago. Illustrates and describes a recently built plant, embodying the latest and best practice in all that is conducive to economical operation. 3000 w. St Ry Rev—July 15, 1900. No. 35433 C.

Prague.

The Electric Central Station at Prague (Die Elektrische Central-station in Prag). Emil Kolben. A long illustrated description of this large central station, which furnishes polyphase current for tramways, power and lighting. 6000 w. Elektrotech Zeitschr—June 28, 1900. No. 35313 B.

St. Helens.

Destructor and Electric Power Station at St. Helens. J. S. Highfield. A short account of the works and results obtained in a combination destructor and electric supply plant which has been working six months. 900 w. Elec Rev, Lond—July 6, 1900. No. 35291 A.

Sao Paulo.

The Sao Paulo Power Plant, Brazil. Illustrated description of an 8,000 H.-P. hydraulic plant for a Brazilian city where coal sells at $10 a ton, making an elaborate station financially advisable. 2300 w. Eng Rec—July 21, 1900. No. 35456.

Savoy.

Hydro-Electric Power Plant at La Praz, Savoy (Usine Hydro-Electrique de la Praz, Savoie). A. Lapouche. An illustrated description of this plant, whose current is used to produce aluminium. An arched steel water pipe serves as a foot-bridge of 50 meters span. 1500 w. Génie Civil—June 23, 1900. No. 35390 D.

Small Stations.

Diverse Service from Small Stations. Alton D. Adams. Discusses the equipment that will best serve the needs of such stations. 1500 w. Elec Rev, N. Y.—July 18, 1900. No. 35427.

Switchboards.

Switchboards and Switches of the Modern Central Station. E. W. Rice, Jr. Extract from a paper read before the Gen. Elec. Engng. Soc. of Schenectady. A discussion of methods, with suggestions. 2400 w. Elec Wld & Engr—June 30, 1900. No. 35126.

Transformers.

Design for a Simple Transformer in Four Sizes. Cecil P. Poole. Illustrates and describes transformers that can be built by any amateur without the use of machine tools. 1200 w. Am Elect'n—July, 1900. No. 35180.

LIGHTING.

Arc Lamps.

The Choice of Arc Lamps. Wilbur M. Stine. Discusses the properties of such lamps, and their adaptability, efficiency and cost of installation and operation. 4000 w. Am Elect'n—July, 1900. No. 35178.

Differential Arc Lamp with Recoil Mechanism for Continuous and Alternating Currents, on the Bardon System (Lampe Différentielle à Mécanisme de Recul pour Courants Continu et Alternatif Système Bardon). M. Aliamet. An illustrated description of arc lamp mechanism. 1400 w. Electricien—May 26, 1900. No. 35552 B.

The Bremer Electric Light System (Das Neue Elektrische Licht System Bremer). W. Wedding. A paper before the Verband Deutscher Elektrotechniker, giving the results of experiments on the Bremer arc lamp, in which the carbons contain metallic salts, such as calcium and magnesium compounds. With curves and tables. 2000 w. Elektrotech Zeitschr—July 5, 1900. No. 35318 B.

Electric Decoration.

The Crest of the Palace of Electricity. From *L'Illustration*. Illustrated description. 1200 w. Sci Am Sup—July 14, 1900. No. 35240.

Electric Tower.

The Pan-American Electric Tower. Illustrated description of the general arrangement of the grounds of the Pan-American Exposition at Buffalo and of its leading feature—an electric tower 375 feet high, explaining a number of the special structural details. 1500 w. Eng Rec—July 21, 1900. No. 35457.

Incandescent Lamp.

The Incandescent Lamp. Ed. C. De Segundo. Discusses the way in which energy is dissipated in an electric incandescent lamp, its efficiency, the improvements made, etc. 1800 w. Elec Rev, Lond—July 20, 1900. Serial. 1st part. No. 35589 A.

A Baseless Incandescent Lamp (Suppresion du Culot dans les Lampes à Incandescence). J. A. Montpellier. An illustrated description of the Hollub lamp, in which metallic terminals are attached directly to a glass projection at the bottom of the bulb. 700 w. Electricien—July 7, 1900. No. 35563 B.

Nernst Lamp.

Nernst Lamp Patents. An account of patents on details of the Nernst lamp system, interesting in showing the difficulties in its commercial development 3300 w. Elec Wld & Engr—July 7, 1900. No. 35173.

Small Towns.

Electricity Supply for Small Towns. Papers by C. S. Vesey Brown and G. M. Harris, read at the Huddersfield convention of the Munic. Elec. Assn. Discusses the system. 5500 w. Elec Engr, Lond—June 22, 1900. No. 35087 A.

Street Lighting.

Street Lighting. H. H. Wait. Abstract of paper read before the Northwestern Elec. Assn. Discusses the cost of arc lighting and the relative economy of open and enclosed arc lamps. 1900 w. Am Elect'n—Aug., 1900. No. 35661.

Train Lighting.

Electric Lighting of Railway Trains. George D. Shepardson. An illustrated account of the "Burlington Limited" train and its lighting and electrical features. It has been in service three years. 3500 w. Elec Wld & Engr—July 7, 1900. No. 35172.

See also Railway Affairs, Equipment.

MEASUREMENT.

Dynamometer.

The Leneveu Rotary Recording Dynamometer (Dynamomètre de Rotation Enregistreur de M. le Capitaine Leneveu). A well illustrated description of a transmitting and registering dynamometer. 5000 w. Rev de Mécanique—May 31, 1900. No. 35569 E + F.

Galvanometer.

A Universal Measuring Instrument for Telegraph Circuits (Ueber ein Universalmessinstrument für Telegraphenleitungen). Dr. F. Breisig. Paper before the Elektrotechnischer Verein describing a convenient form of galvanometer for telegraph testing work, with illustration and diagrams. 3200 w. Elektrotech Zeitschr—June 28, 1900. No. 35315 B.

Indicating Instruments.

Electrical Measuring Instruments. J. Franklin Stevens. A discussion of commercial direct reading indicating instruments, such as are found in every-day use, and the requirements. 7000 w. Jour Fr Inst—July, 1900. No. 35161 D.

Indicator.

Electric Indicator for Determining the Relative Position of the Cranks of Engines in Operation (Elektrischer Indikator zur Bestimmung der Relativen Kurbellage Laufender Maschinen). P. v. Kowaleff. An illustrated description of an apparatus, consisting of a voltmeter in circuit with commutators and a source of current, which indicates the relative position of the cranks of engines driving alternating and rotary current dynamos. 700 w. Elektrotech Zeitschr—June 21, 1900. No. 35310 B.

Photometry.

On the Photometry of Arc Lamps. F. W. Carter. Gives results of experience in testing, showing how to carry out the tests, and giving details of devices for overcoming the difficulties and placing the results on a rational basis. Ill. 1600 w. Elec Rev, Lond—July 13, 1900. Serial. 1st part. No. 35475 A.

Rotary Current.

Rotary Current Meters (Ueber Drehstrom-Zähler). J. A. Möllinger. A mathematical discussion of rotary current wattmeters. Serial. 1st part. 3000 w. Elektrotech Zeitschr—July 12, 1900. No. 35319 B.

Traction.

Traction Meter for Electric Cars (Zug-

kraftmesser für Elektrische Bahnwagen). Gisbert Kapp. A paper before the Verband Deutscher Elektrotechniker, giving the theory and a description of a simple apparatus, consisting of a horizontal tube with vertical legs, in which the height of liquid in one of the legs indicates the tractive force. With diagram and illustration. 1200 w. Elektrotech Zeitschr—July 12, 1900. No. 35321 B.

POWER APPLICATIONS.

Automobile.

See Mechanical Engineering, Automobilism.

Canal Haulage.

Electric Traction on Canals in Belgium. Illustrated description of the system of M. Gérard, installed between Brussels and Charleroi. 1500 w. Tram & Ry Wld—July 5, 1900. No. 35487 A.

Cripple Creek.

Electric Power in Cripple Creek District. J. W. Dickerson. Illustrated description of the generating equipment, steam plant, and electrical features. 1000 w. Mod Mach—July, 1900. Serial. 1st part. No. 35121.

Electric Elevator.

The Electric Elevator for Cars at the Custom House Railway Station in Vienna (Die Elektrischen Waggonhebewerke am Bahnhof Hauptzollamt in Wien). Anton Freissler. An address before the Oest. Ing. und Arch, Verein, giving an illustrated description of elevators for lifting freight cars from the track level 19 feet to the main floor of the custom house. 3500 w. Zeitschr d Oest Ing u Arch Ver—June 1, 1900. No. 35342 B.

Electric Hoisting.

The Electric Hoisting Plant of the Thiederhall Company at Thiede, near Brunswick (Die Elektrische Förderanlage der Aktien-Gesellschaft Thiederhall in Thiede bei Braunschweig). Prof. O. Hoppe. The current is generated above ground and an electric motor 300 meters underground drives the rope hoist from the 500 meter level. Illustrated. 4000 w. Glückauf—June 9, 1900. No. 35350 B.

Electric Pump.

A New Form of Electric Pump for Underground Use. Emerson Bainbridge. Read before the Brit. Inst. of Min. Engs. Describes the Hatfield Electric Pump, stating its advantages. 900 w. Col Guard—June 22, 1900. No. 35117 A.

Electric Turrets.

The Schneider-Canet Electric Turrets (Les Tourelles Electriques Schneider-Canet). Geo. Dary. A general description of electric mechanism for moving turrets and big guns on men-of-war. 1200 w. Electricien—June 16, 1900. No. 35559 B.

Mining Machinery.

Electric Mining Machinery in the British Collieries. Sydney F. Walker. A richly-illustrated review; this part is devoted to machinery for coal-cutting, pumping, and mine haulage. 3800 w. The Engineering Magazine—Aug., 1900. No. 35637 B.

Motor Applications.

Some Notes on the Application of Motors in an Iron and Steel Plant. Illustrates and describes interesting heavy applications in operation at the National Steel Co.'s works at Youngstown, Ohio. 3000 w. Elec Wld & Engr—July 14, 1900. No. 35232.

Motors.

I. Power Supply by Single-Phase Motors. T. P. Wilmshurst. II. Notes on the Maintenance of Motors on Hire from an Electricity Works. C. A. L. Prussman. Two papers read before the Huddersfield Convention of the Munic. Elec. Assn. and discussed together. 7800 w. Elec Eng, Lond—June 29, 1900. No. 35214 A.

Oculist.

Electro-Magnet Extractor for Oculists (Electro-Aimant Extracteur pour Oculistes). M. Aliamet. A brief illustrated description of a powerful electro-magnet for extracting bits of iron from eyes. 250 w. Electricien—June 23, 1900. No. 35561 B.

Printing Plant.

Electrical Equipment of the Printing Plant of the St. Louis *Republic*. Illustrated description. 1700 w. Eng News—July 5, 1900. No. 35182.

TRANSMISSION.

Copper Saving.

Copper Saving in the Joint Transmission of Direct and Alternating Currents. Frederick Bedell. Abstract of a paper read at N. Y. meeting of the Am. Assn. for the Adv. of Science, with editorial. A mathematical discussion of the problem, with editorial on the practical application. 3000 w. Elec Wld & Engr—June 30, 1900. No. 35127.

MISCELLANY.

Address.

The Municipal Electrical Association Presidential Address by Mr. A. B. Mountain, at Huddersfield. Discusses the work of the association. 3300 w. Elect'n, Lond—June 22, 1900. No. 35090 A.

Bombay.

Electric Works in Bombay. Copy of the agreement which it is proposed should be adopted by any firm to whom permission for electric supply is granted. 1700

w. U. S. Cons Repts, No. 774—July 7, 1900. No. 35154 D.

Electrical Congress.

International Electrical Congress (Congrès International D'Electricité). The provisional program of the congress, which meets August 18 to 25, at the Paris Exposition. 1400 w. Electricien—June 9, 1900. No. 35558 B.

Lessons.

Lessons in Modern Electrical Engineering. The first of a series of articles reviewing progress since 1890, and facts to be remembered. 1800 w. Builder—July 7, 1900. Serial. 1st part. No. 35294 A.

Liabilities.

The Common Law Liabilities of Electrical Undertakings. A summary illustrating the more important rules which must guide in negotiations with the public in England. 2200 w. Engng—July 6, 1900. No. 35280 A.

Lightning Rods.

Discussion of Regulations for the Protection of Buildings against Lightning, drawn up by a Committee of the Elektrotechnischer Verein (Antrag des Technischen Ausschusses auf Annahme der "Leitsätze über den Schutz der Gebäude gegen den Blitz" durch den Elektrotechnischen Verein). Discussion at a meeting of the Verein, opened by K. Strecker. 11000 w. Elektrotech Zeitschr—July 12, 1900. No. 35322 B.

Paris Exposition.

Opening of the U. S. Sections in Electricity Building, Paris Exposition. An account of the opening and plans of the American Court of Honor, with illustrations. 2000 w. Elec Wld & Engr—June 30, 1900. No. 35124.

GAS ENGINEERING

Acetylene.

The Use of Acetylene in Railway Station and Train Lighting. A. Lipschutz. Describes its use for station lighting and gives details of a plant in practice. Also considers its adaptability to train lighting. 6500 w. Jour Assn of Engng Socs—June, 1900. No. 35402 C.

Address.

President's Address at the Annual Meeting of the Society of Chemical Industry, London. Abstract. Deals with technical education, water gas, incandescent gas mantles, and other topics. 4000 w. Jour Gas Lgt—July 24, 1900. No. 35652 A.

Benches.

The Use of Crude Petroleum for Firing Benches. R. M. Powers. Read before the Pacific Coast Gas Assn. On the employment of oil as a fuel under benches. Also general discussion. 3700 w. Am Gas Lgt Jour—Aug. 6, 1900. No. 35709.

Boston, Mass.

The Gas Supply of Boston, Mass. J. H. Gray, in *Quarterly Journal of Economics*. Abstract showing American financial methods as applied to gas undertakings. 1800 w. Jour Gas Lgt—July 10, 1900. Serial. 1st part. No. 35483 A.

Coal Tars.

The Composition of Some Coal Tars from American Gas-Works. Alfred H. White and H. W. Hess. Read before the N. Y. section of the Soc. of Chem. Ind. Explains the reasons for the feeble condition of the coal-tar industry in America, giving results of analyses. 1800 w. Jour Gas Lgt—July 17, 1900. No. 35528 A.

Fuel.

Twentieth Century Energy. Alton D. Adams. Arguing that gas and electricity are the forms of energy that will prevail. 2200 w. Sci Am—July 14, 1900. No. 35238.

Gas Manufacture.

Modern Methods of Manufacturing Gas; With a Description of Its Distribution under High Pressure. Frederick H. Shelton. Reviews the processes, and their advantages and disadvantages, and advocates high pressure distribution. Also discussion of the paper. 4800 w. Pro Engs' Club of Phila—July, 1900. No. 35276 D.

London.

The Price of Gas in London. Abstract of a memorandum on the increase of charges made by gas companies, due to the high price of coal. 2000 w. Engr, Lond—July 20, 1900. No. 35629 A.

The Gas Supply of the Metropolis. On the bills before the English Parliament. 2000 w. Engr, Lond—July 6, 1900. Serial. 1st part. No. 35412 A.

Wood Gas.

The Riché Gas Apparatus (Les Gazogènes Riché). P. Corbier. An illustrated description of this apparatus for producing gas from wood, to be used principally for power and heating purposes. 2500 w. Génie Civil—June 30, 1900. No. 35393 D.

MARINE AND NAVAL ENGINEERING

Balanced Rudders.

The Distribution of Pressure Due to Flow Round Submerged Surfaces, with Special Reference to Balanced Rudders. H. S. Hele-Shaw. Read before the Inst. of Nav. Archts., England. On the manner of investigating the relative distribution of the pressure. Ill. 2700 w. Engng—July 13, 1900. Serial. 1st part. No. 35505 A.

Bilge-Keels.

The Steadying of Ships. G. H. Bryan. Describes investigations made, showing that the efficiency of bilge-keels in modifying the rolling of ships may be greatly increased by the action of the sides of the ship itself. Abstract of paper read before the Inst. of Nav. Archts, 1800 w. Nature—June 21, 1900. No. 35086 A.

Cable Steamer.

The Cable-Laying Steamer "Von Podbielski." Illustrated description of Germany's first cable-laying steamer, and its equipment. 3000 w. Engng—June 22, 1900. No. 35113 A.

Cruiser.

Russian Cruiser "Variag." Illustration and brief description of vessel built in the United States for Russia. 300 w. Marine Rev—July 5, 1900. No. 35167.

Deutschland.

The Hamburg-American Liner "Deutschland." Remarks on recent progress in steamship construction with illustrations and interesting features of the vessel named. 1500 w. Sci Am—Aug. 4, 1900. No. 35649.

Dredges.

Dredges on the Mississippi. Waldon Fawcett. Brief illustrated descriptions of some of the dredges used. 1500 w. Sci Am—July 7, 1900. No. 35132.

Excursion Boat.

Elegant Western River Excursion Packet. Illustration and description of the new steamboat "Francis J. Torrance," built for service at Pittsburg. 2000 w. Naut Gaz—July 26, 1900. No. 35547.

Ferryboats.

The Harbor Ferryboats of 1850. Reprint of an article appearing in the *N. Y. Herald* on July 2, 1850, giving a correct list of the boats and the companies operating, and interesting facts of vessels in N. Y. harbor. 2000 w. Naut Gaz—July 26, 1900. No. 35548.

Hoboken Fire.

Hoboken's Holocaust. An account, with editorial comment, of the terrible fire that destroyed the North German Lloyd's piers and vessels. 5000 w. Fire & Water—July 7, 1900. No. 35158.

The Burning of the North German Lloyd Steamships and Docks, Hoboken, N. J. An illustrated account of this disaster, with editorial comment. 3000 w. Sci Am—July 14, 1900. No. 35237.

The Lessons of the New York Harbor Fire. Editorial briefly describing the conditions at the fire which destroyed the piers and steamships of the N. German Lloyd Co. at Hoboken, and commenting on steps needed to avert a repetition of the catastrophe. 2200 w. Eng News—July 14, 1900. No. 35256.

See also Wharf under Civil Engineering, Construction.

Marine Boilers.

The Making and Testing of Several Types of Marine Boilers (Ausführung und Erprobung einiger Schiffskesseltypen). H. Görris. A review of the subject, with particular reference to tests and experiments made on boilers of British naval vessels. Illustrations and tables. Serial. 2 parts. 9000 w. Zeitschr d Ver Deutscher Ing—June 30, July 7, 1900. No. 35303 each D.

Propulsion.

Direct Application of Electricity to the Propulsion of Ships. William F. Durand. A reply to certain of the statements made by Nikola Tesla in the June, 1900, issue of *The Century Magazine*. 2800 w. Marine Engng—July, 1900. No. 35205 C.

Improvements in Screw Propulsion. I. McKim Chase. Considers methods of utilizing the discharged water from a screw propeller to aid propulsion. 1000 w. Marine Rev—July 5, 1900. No. 35168.

Schooner.

A Famous Old Schooner. From the Boston *Evening Transcript*. Reviews the history of the "Polly, of Calais, Me." in service ninety-six years. 1400 w. Marine Rev—July 12, 1900. No. 35235.

Shafts.

How the Shaft of the Transport "Fazilka" was Repaired. Illustrated description of the repair of a shaft fractured in two places inside the stern tube, forcing itself through the tube. 1000 w. Engr, Lond—June 29, 1900. No. 35216 A.

Ship-Building.

The Ship Building Yards of the United States. Waldon Fawcett. A continuation of a former paper. Reviews the location, growth, equipment, and output of the principal yards of the coast and the lakes. Very fully illustrated. 4000 w. The Engineering Magazine—Aug., 1900. No. 35633 B.

A Short Account of Some of the Changes Which Have Been Introduced into the Types, Sizes and Construction of Ships During the Last Forty Years. B. Martell. Abstract of a paper read before the Inst. of Naval Archts. 4000 w. Engs' Gaz—July, 1900. No. 35213 A.

Progress of Warships and Machinery Building in England. Notes on the progress of work now in hand in English ship yards and marine engine works. 3400 w. Engr, Lond—June 29, 1900. No. 35215 A.

Bath Iron Works, Ltd. A sketch of its history and an illustrated description of the plant. 3300 w. Marine Rev—July 19, 1900. No. 35467.

Steamboats.

New York's Passenger Steamboats of 1850. Illustrated review of the Sound and river boats of fifty years ago. 2800 w. Naut Gaz—July 12, 1900. Serial. 1st part. No. 35259.

Twin-Screw Steamboat "Pennsylvania," Built for the Cape Charles Route. Illustration, plans and cross sections, with detailed description. 2400 w. Marine Engng—July, 1900. No. 35204 C.

Steamship.

A New Atlantic Liner. Describes the twin-screw steamer "Vaderland," of the Red Star service. 2500 w. Engng—July 13, 1900. No. 35504 A.

New Coast Steamship. Illustration and description of the "Grecian," built for the Boston and Philadelphia route. 2000 w. Naut Gaz—July 12, 1900. No. 35258.

Ocean Steamers Plying Out of New York Fifty Years Ago. An illustrated description of the types of ocean steamers in service in 1850. 3000 w. Naut Gaz—July 19, 1900. No. 35469.

The Twin-Screw Channel steamer "Alberta." Illustrated description of a steamer especially built for the Paris Exposition traffic between Southampton and Havre. 1600 w. Engng—July 13, 1900. No. 35502 A.

Torpedo Vessels.

Are the Last Knots of Speed in Torpedo Vessels Worth Their Cost? Editorial discussion claiming that it has not yet been demonstrated that phenomenal bursts of speed in these vessels will be of value in actual warfare. 2200 w. Eng News—July 5, 1900. No. 35185.

Transportation.

Ocean Transportation to Eastern Asia. Eugene T. Chamberlain. The importance of improved facilities for ocean transportation is shown. 2000 w. N Am Rev—July, 1900. No. 35155 D.

Tugs.

Fine New Coast Tug. Illustrates and describes the new sea-going tug-boat "Abram Minis." 1800 w. Naut Gaz—July 19, 1900. No. 35468.

Turrets.

Gruson Rotating Turrets. T. Guilford Smith. Illustrates and describes the construction and merits of this class of gun-protection. 2300 w. Trans Am Inst of Min Engs—June, 1900. No. 35515 D.

Water-Tubes.

Water-Tube Boilers in Warships. Tabulated lists of the principal types used, or to be used, in warships, with remarks. 900 w. Engr, Lond—July 13, 1900. No. 35506 A.

Belleville Boilers. Editorial on the debate in the House of Commons, and the Admiralty Memorandum Respecting Water-Tube Boilers in H. M. ships. 4500 w. Engng—July 20, 1900. No. 35573 A.

Mr. Goschen's Memorandum on Water-Tube Boilers. A statement dealing with ships fitted with Belleville boilers, or with boilers of large tube types. 7500 w. Engr, Lond—July 20, 1900. No. 35630 A.

Yacht.

A Yacht That Sails Itself. Illustrated description of the little model yacht "Nydia," which is automatically controlled. 1400 w. Sci Am—July 28, 1900. No. 35530.

Yacht Plumbing.

The Ellis System of Yacht Plumbing. Illustrated description of the plumbing which has been installed in the steam yacht "Saghaya." A cesspool tank is used which empties automatically. 900 w. Met Work—July 21, 1900. No. 35435.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Electric Phaeton.

Working Drawing of an Electric Phaeton. From *The Hub*. Full explanation of drawing. 2800 w. Sci Am Sup—July 14, 1900. No. 35241.

Evolution.

The Evolution and Present Status of the Automobile. William Baxter, Jr. Historical review dating back to the middle of the sixteenth century, and illustrating many early vehicles. 3000 w. Pop Sci M—Aug., 1900. No. 35537 C.

Heavy Vehicles.

Heavy Motor Vehicles for Road Service. Fred M. Maynard. Gives valuable data of cost, compared with railway,

canal, and horse haulage, and discusses the essential principles of design of heavy wagons. Serial. 1st part. 3600 w. The Engineering Magazine—Aug., 1900. No. 35639 B.

Imperfections.

Automobile Imperfections. W. H. Booth. Compares the automobile with the horse, and shows the need of wheel guards when the horse is no longer used. 1200 w. Am Mach—July 26, 1900. No. 35526.

Locomobile.

A Locomobile with Compound Engine (Machine Compound Demi-Fixe à Faisceau Tubulaire Amovible). An illustrated description of this locomobile, made by Wolf, of Magdeburg, in which the engine cylinders are placed in the steam dome on top of the boiler. 700 w. Génie Civil—June 23, 1900. No. 35391 D.

Mechanical Propulsion.

The Recent Trials of Motor Vehicles. H. S. Hele-Shaw. Supplementary paper to the one on "Road Locomotion," read before the Inst. of Mech. Engs. 1200 w. Horseless Age—July 18, 1900. No. 35298.

Paris Exhibition.

Automobile Carriages at the Paris Exhibition. The first of a series of articles describing the large and important collection of exhibits. 2200 w. Engr, Lond—July 20, 1900. Serial. 1st part. No. 35626 A.

Electric Automobiles at the Paris Exposition. Illustrates and describes some of the vehicles on exhibition. 2800 w. Elec Wld & Engr—July 14, 1900. No. 35234.

HYDRAULICS.

Riedler Pump.

Riedler Express Pumps (Riedler-Expresspumpen). Prof. Karl Habermann. An illustrated description of these high-speed pumps, which are often directly coupled to electric motors, with a list of pumps installed in Germany, Austria and Denmark. 1 plate. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—June 23, 1900. No. 35357 B.

Water Power.

On Water Powers, with Particular Reference to the Utilization of the Power of the "Gesäuse" Cataract, in Styria (Ueber Wasserkräfte, insbesondere über die Ausnützung der Wasserkraft im Gesäuse). Dr. P. Forchheimer. Abstract of an address at the Polytechnic Club, Gratz, with table of Swiss improved water powers, and plans for using the Gesäuse water power. 1200 w. Wiener Bauindustrie Zeitung—June 21, 1900. No. 35368 D.

MACHINE WORKS AND FOUNDRIES.

American Competition.

Has the German Mechanical Industry Anything to Learn from the American (Kann die Deutsche Maschinenindustrie von der Amerikanischen Lernen)? H. Unger. A paper before the Verein Deutscher Maschinen-Ingenieure, discussing American competition in Germany and giving illustrated descriptions of American machine tools. Serial. 1st part. 6000 w. Glaser's Annalen—July 1, 1900. No. 35324 D.

Arrangement and Design.

Lugansk and the Hartmann Machine Company's Locomotive Works. Illustrated description of a model locomotive factory. 2200 w. Engr, Lond—July 6, 1900. No. 35414 A.

New Works of the English Electric Manufacturing Company, Limited. An illustrated detailed description of a large plant and its equipment. 5000 w. Tram & Ry Wld—July 5, 1900. No. 35485 A.

The New Works of the English Electric Manufacturing Co. at Preston. An illustrated detailed description of the shops and their equipment, with account of the organization of the company. 4200 w. Elect'n, Lond—June 22, 1900. No. 35089 A.

Castings.

Casting a Double-Thread Worm. L. C. Jewett. Sketch and brief description showing a method of molding a double-threaded worm to be cast vertically and without joint seams. 400 w. Am Mach—July 5, 1900. No. 35171.

The Steel Castings Industry of To-day. M. A. Tissot. Read before the Min. & Met. Cong. at Paris. Reviews the improvements that have made possible the success. 1000 w. Ir Trd Rev—July 12, 1900. No. 35243.

Dies.

Two Forming Dies. A. H. Cleaves. Illustrated description. 400 w. Am Mach—July 26, 1900. No. 35527.

Gear-Teeth.

The Fellows Machine and Cutter for Generating Gear-Teeth. Report of the Franklin Inst. committee, investigating the invention of E. R. Fellows. Ill. 2500 w. Jour Fr Inst—Aug., 1900. No. 35591 D.

Guns.

Notes on the Construction of "Long Cecil," a 4.1-Inch Rifled Breechloading Gun, in Kimberley During the Siege 1899-1900. Edward Goffe. 4 plates. Describes the construction. 5500 w. Inst of Mech Engs—1900. No. 35198 D.

Ladle Carriage.

Carriage for a Ladle of 20 Tons' Capac-

ity (Giesspfannenwagen für 20,000 kg Pfanneninhalt). An illustrated description of two carriages, one operated by steam and hydraulic power, the other electrically, for transporting and pouring ladles containing molten metal. 800 w. Stahl und Eisen—June 15, 1900. No. 35-335 D.

Machine Tools.

Machine Tools at the Paris Exposition (Die Weltausstellung in Paris, 1900, Werkzeugmaschinen). Hermann Fisher. A general review of the machine tool exhibits at the Exposition. Serial. 1st part. 3500 w. Zeitschr de Ver Deutscher Ing—July 7, 1900. No. 35306 D.

Criticisms on the General Construction of Machine Tools. A. R. Bellamy. Read before the Manchester (Eng.) Assn. of Engs. 4500 w. Am Mach—July 5, 1900. No. 35169.

Molding.

Molding a Lathe Bed. L. C. Jewett. Illustrates and describes a method of doing this work. 1000 w. Am Mach—July 5, 1900. No. 35170.

Percussive Tool.

An Inertia Valve Percussive Tool. Chester B. Albree. States the advantageous qualities of compressed air over steam, gives an outline of the development of percussive engines, and a description of the type named in the subject, with a discussion of some of the features in its design. Ill. 7000 w. Pro Engs' Soc of W. Penna—May, 1900. No. 35430 D.

Premium Plan.

The Determination of Time Limits Under the Premium Plan. George H. Hall. Discusses the importance of the proper establishment of the basis, showing how limits are determined in one shop and the means by which the data for their establishment are determined. 1600 w. Am Mach—July 12, 1900. No. 35201.

Pulleys.

Keys and Split Hubs. Illustrates and describes some methods of keying pulleys to their shafts. 1200 w. Mach, N. Y.—July, 1900. No. 35129.

Sheet Metal.

A Job in Drawing and Forming Sheet Metal. Joseph V. Woodsworth. Illustrated detailed description of the work. 600 w. Am Mach—July 12, 1900. No. 35203.

Springs.

Flat Springs. Robert A. Bruce. Discusses what design will secure the best economy of material, and gives a table to enable designers to settle the dimensions of a given spring with the minimum amount of trouble. 1500 w. Am Mach—July 19, 1900. No. 35431.

Works Management.

Commercial Organization of the Machine Shop. Hugo Diemer. Part 3 of Prof. Diemer's series deals with storeroom management—location and arrangement of the room, section store-rooms, reservation of special orders, forms of rcord and report. 3400 w. The Engineering Magazine—Aug., 1900. No. 35636 B.

POWER AND TRANSMISSION.

Bearings.

Ball Bearings. D. T. Randall. Notes on the number and size of balls to be used. 2200 w. Mach, N. Y.—July, 1900. No. 35130.

Compressed Air.

Compressed Air Plant at Ainsworth, B. C. Illustrated detailed description of a plant run by compressed air derived direct from falling water. 2200 w. B. C. Min Rec—July, 1900. No. 35242 C.

A New Device for Reheating Compressed Air for Use in Pumps. E. A. Rix. Illustrates and describes this device for increasing efficiency. 1000 w. Compressed Air—July, 1900. No. 35405.

Applications of Compressed Air in Railroad Shop Practice. Edward C. Schmidt. From an address before the St. Louis Ry. Club. Gives figures relating to saving in time and labor, and describes uses to which it is applied. 1800 w. Compressed Air—July, 1900. No. 35404.

Flying Machine.

The Building of the Kress Flying Machine (Ueber den Bau des Kress 'chen Drachenfliegers). W. Kress. An address before the Oest. Ing. und Architekten Verein, giving a report of progress in the construction of this aeroplane machine. 1200 w. Zeitschr d Oest Ing u Arch Ver—June 15, 1900. No. 35344 B.

Lubrication.

A Few Suggestions on the Use and Abuse of Lubricants. C. Going. On the waste due to the use of automatic oiling devices, and to needless use of fluid lubricants, the materials used, etc. 1200 w. Marine Engng—July, 1900. No. 35206 C.

The "Oiliness" of Lubricating Oils. An argument, quoting from various authors, and favoring capillarity and adhesiveness as factors of efficient lubrication. 4000 w. Engr, Lond—June 22, 1900. No. 35-109 A.

Mechanical Handling.

Mechanical Handling of Ore and Coal (Mechanische Handhabung von Erzen und Kohlen). H. Frahm. A long illustrated article giving an account of American methods and apparatus for conveying and handling ore and coal. Serial. 1st part. 3500 w. Stahl und Eisen—May 15, 1900. No. 35325 D.

Motive Power.

The Harnessing of Bacchus. An articles on the application of alcohol to power purposes. 1500 w. Auto Jour—July, 1900. No. 35493 A.

Power Development.

See same title under Steam Engineering.

Power Plants.

The Borsig Triple-Expansion Engine at the Paris Exposition. Illustrated description of the principal features of a marine type, four-cylinder engine and alternating generator direct-connected to it. 1500 w. Eng Rec—July 14, 1900. No. 35247.

Shafting vs. Electricity.

Power Transmission by Shafting vs. Electricity. Abstract of a committee report presented at the convention of the Am. Mas. Mechs.' Assn., concluding that the latter is more effective in large shops. 5800 w. Eng News—July 12, 1900. No. 35253.

Steam Hammers.

Variation in Steam Hammer Design and Cost—German and American. Henry Hess. Shows graphically various relations, and compares designs and costs. 600 w. Am Mach—July 12, 1900. No. 35202.

SPECIAL MOTORS.

Compressor Explosions.

Explosions and Ignitions in Air Compressors and Receivers. Alfred George White. Excerpt transactions Inst. C. E. An account of an explosion, with a description of the compressor, and the writer's explanation of the cause. 1600 w. Compressed Air—July, 1900. No. 35406.

Gas Engine.

The Gas Engine in Practical Use. J. D. Lyon. Reviews the development of the gas engine and its increasing use as a factor in the production of power. Ill. 3800 w. Pro Engs' Soc of W Penna—April, 1900. No. 35428 D.

Gas Engines for Tramway Power Stations. Explains the fundamental principles of the gas engine, and gives facts and information concerning their application to the working of tramways and light railways. Ill. 4800 w. Tram & Ry Wld—July 5, 1900. No. 35489 A.

Gas Engines and the Economy of Gasoline Engines for Small Power. John Wilkes. Read before the Engng. Assn. of the South. Considers the design, construction and operation of these engines, and reviews their history. 3500 w. W Elect'n—July 21, 1900. No. 35474.

Test of a 550-Horse Power Gas Engine. Describes 5-hour tests, giving high results. 400 w. Eng Rec—July 7, 1900. No. 35152.

Test of Otto Gas Engine at Different Loads. A review of experiments on a 10 H.-P. engine. 800 w. Eng Rec—July 21, 1900. No. 35460.

Gas Engine Test.

Testing a 600-Horse Power Blast-Furnace Gas Engine. An account of the results of tests made with the Delamare-Debouteville and Cockerill engine. Ill. 1500 w. Col Guard—June 22, 1900. No. 35114 A.

Gasoline Motors.

Pattern Making for Gasoline Motors. W. O. Anthony. The first of a series on pattern-making for small gas engines intending to fully cover the subject. Ill. 3500 w. Horseless Age—July 18, 1900. Serial. 1st part. No. 35297.

Ignition.

Premature Ignition in Gas Engines. E. W. Roberts. Discusses the effects of ignition in advance of the proper time, the location of the ignition points, with illustrations of faults in engine design. 1500 w. Mod Mach—July, 1900. No. 35122.

Oil Engine.

Low Cost Power for Electric Lighting, Pumping, Machine Shops, etc. Charles Hansel. Illustrated description of a 25-H.-P. oil engine, and a statement of the advantages from its use. 2200 w. R R Gaz—July 20, 1900. No. 35445.

Power Development.

See same title under Steam Engineering.

Valves.

The Valves of Internal Combustion Engines. James D. Roots. Considers recent and existing practice, giving illustrations. 4000 w. Engr, Lond—July 20, 1900. No. 35625 A.

STEAM ENGINEERING.

Boilers.

Boilers at the Paris Exhibition. General review of the exhibits, noting the preponderance of the water-tube type. 1900 w. Engr, Lond—June 22, 1900. Serial. 1st part. No. 35108 A.

A Letter on Soda, in Answer to an Inquiry. W. H. Edgar. On the action of soda ash or caustic soda in steam boilers. 2200 w. Loc Engng—Aug., 1900. No. 35577 C.

The Prevention of Scale and Corrosion in Boilers. R. D. Summerfield. The need of water analysis, the use of soda, and the treatment of acid waters and other substances are discussed. 2400 w. Elec Eng, Lond—July 20, 1900. No. 35584 A.

The Solignac Circulating Boiler (Sur la

Chaudière Mixte, Système Solignac). A. Brüll. An illustrated description of a boiler in which the water circulates from a large upper reservoir through tubes in which it is converted into steam, which then returns to the upper part of the reservoir. 1200 w. Bull de la Soc d'Encour—May 31, 1900. No. 35564 G.

See also Marine and Naval Engineering; Marine Boilers and Water-Tube.

Boiler Accidents.

The Efficacy of Boiler Inspection in the German Empire (Ueber die Wirksamkeit der Dampfkesselüberwachung im Deutschen Reiche). C. Bach. A review of accident statistics, showing that accidents due to boiler explosions, etc., have diminished considerably in proportion to other accidents. With tables and curves. 1000 w. Zeitschr d Ver Deutscher Ind—June 23, 1900. No. 35301 D.

Explosion of a Water-Tube Boiler at Deptford. Report of the British Board of Trade, of interest because of its special bearing on the management of water-tube boilers. 2200 w. Engr, Lond—June 29, 1900. No. 35217 A.

Condensers.

Evaporative Condensers. Harry G. V. Oldham. An interesting and extended description, with plates, discussion of advantages, principles, etc., and lengthy general discussion. 23400 w. Inst of Mech Engs—April, 1899. No. 35200 D.

Heat Distribution.

Experiments with a Boiler Arranged to Serve as a Calorimeter for Determining the Heating Value of Fuel. Charles J. Slipper, Mortimer Harrison, Jr. and Edward C. Schmidt. Graduation thesis. Tests made at Stevens Inst. to determine the heating value of coal under the conditions of its use with a boiler. Ill. 6500 w. Stevens Ind—July, 1900. No. 35616 D.

High-Speed Engine.

High-Speed Vertical Triple-Expansion Engine; Central Electric Station, Vienna, Austria. Illustrated description of an engine installed in an electric-lighting station which possesses many features of interest. Special attention is called to the method of governing. 1100 w. Eng News—Aug. 2, 1900. No. 35689.

Power Development.

The Future of Power Development. Wm. D. Ennis. Considers the probability of displacement of the steam engine by other motors, or its radical improvement in the matter of economy. 2300 w. The Engineering Magazine—Aug., 1900. No. 35638 B.

Pumping-Engines.

The Pumping-Engines in the City of Philadelphia. Henry G. Morris. A brief description of the different styles and types of pumping-engines that have been and now are in use. Also discussion. 6000 w. Pro Engs' Club of Phila—July, 1900. No. 35277 D.

Steam Engines.

The Efficiency of the Steam Engine. Ed. C. de Segundo. Remarks on the Behrend and Zimmerman engine, and results obtained from other engines. 1000 w. Elec Rev, Lond—June 22, 1900. No. 35088 A.

Steam Turbine.

The Parsons Steam Turbine at Elberfeld (Die Parsons-Dampfturbine). A short illustrated description of a steam turbine driving a 1,000-kilowatt dynamo. 1 plate. 300 w. Schweiz Bauzeitung—June 16, 1900. No. 35363 B.

Steam Turbines (Die Dampfturbinen). A well illustrated description of various Laval and Parsons turbines in practical operation. Serial. 2 parts. 1 plate. 4000 w. Schweiz Bauzeitung—May 26, June 2, 1900. No. 35361 each B.

Test of a Steam Turbine Driving a Rotary Current Dynamo (Versuche an einer Dampfturbine mit Wechselstrommaschine). W. H. Lindley, M. Schröter and H. F. Weber. A full account of an acceptance test made of a Parsons steam turbine driving a 1,000-kilowatt rotary current dynamo in the city electrical works at Elberfeld, Germany. Serial. 2 parts. 6500 w. Zeitschr d Ver Deutscher Ing—June 30, July 7, 1900. No. 35302 each D.

Thermodynamics.

Graphic Calorimetry of the Steam Engine (Calorimétrié Graphique de la Machine à Vapeur). Fritz Krauss. (French translation by Ch. Bellens.) An illustrated account of graphical methods in thermodynamics, particularly of entropy diagrams. 9000 w. Rev de Mécanique—May 31, 1900. No. 35568 E + F.

Twin-Tandem Engine.

Twin-Tandem Hoisting Engine at the Scharnhorst Mine (Zwillings-Tandem-Fördermaschine der Zeche Scharnhorst). F. Schulte. An illustrated description, with diagrams and indicator cards. 2 plates. 1700 w. Glückauf—July 1, 1900. No. 35351 B.

Valve-Gear.

The Design of Cut-Off Slide-Valve Gear (Zur Beurteilung von Expansionsschiebersteuerungen). Prof. A. Bantlin. An illustrated article on the design of slide-valve gear, with special reference to the securing of ample admission of steam. 3500 w. Zeitschr d Ver Deutscher Ing—July 7, 1900. No. 35307 D.

MISCELLANY.

Aeronautics.

The New Air Ship of M. de Santos

Dumont. Francis P. Mann. Illustrates and describes an air ship that is to compete for the prize of 200,000 francs, offered by M. Henry Deutsch, of Paris. 1000 w. Sci Am—July 7, 1900. No. 35133.

Agricultural Show.

Royal Agricultural Show at York. Illustrates and describes some of the implements exhibited. 5200 w. Engr, Lond—June 22, 1900. No. 35110 A.

Breech Blocks.

Krupp Breech Blocks (Kruppsche Geschützverschlüsse). J. Castner. An illustrated description of various kinds of breech mechanism. Serial. 2 parts. 8000 w. Stahl und Eisen—June 15, 1900. No. 35330 each D.

Education.

Necessary Points in Mechanical Knowledge. Walter J. May. A criticism of many of the attempts made in the preliminary education of boys intended for mechanical trades. 1700 w. Prac Engr—June 22, 1900. No. 35092 A.

Engineering Education in the United States at the End of the Century. Ira O. Baker. Condensed address of the president of the Soc. for the Promotion of Engng. Ed., at N. Y. meeting. 2000 w. Ry Age—July 6, 1900. No. 35175.

Status and Tendencies of Engineering Education. Robert Fletcher. Read at N. Y. meeting of Soc. for Promotion of Engng. Ed. Disscusses whether the profession is overcrowded, the work of the schools, present conditions and apparent tendencies. 1500 w. Ry Age—July 6, 1900. No. 35176.

Etching.

The Levy Acid-Blast Method of Etching Metal Plates. Report of Franklin Inst. committee on the invention of Louis E. Levy. 1200 w. Jour Fr Inst—Aug., 1900. No. 35592 D.

Philadelphia Exposition.

The Export Exposition at Philadelphia in 1899 (Die Export-Ausstellung in Philadelphia, 1899). Richard Knoller. The official Austrian report, containing a general description of the exhibits, with illustrations. Serial. 2 parts. 10000 w. Zeitschr d Oest Ing u Arch Ver—June 8, 15, 1900. No. 35343 each B.

Printing Machines.

Some Printing Machines at the Paris Exhibition. Illustrates and describes the exhibits of printing machinery. 2400 w. Engng—June 29, 1900. No. 35221 A.

Prizes.

Program of Prizes Offered by the Société d'Encouragement in 1901 and the Following Years (Programme des Prix Proposés par la Société d'Encouragement pour l'Industrie Nationale à Décerner dans les Années 1901 et Suivantes). A long list of general and special prizes and medals offered in various departments of science and art. 10000 w. Bull de la Soc d'Encour—May 31, 1900. No. 35566 G.

Standardization.

Standardization. J. E. Sweet. Read before the Engine Builders' Assn. of the U. S. Showing the advantages of making and using standard sizes. 2800 w. Am Mach—July 19, 1900. No. 35432.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

Little Things at Anthracite Collieries. Lee C. Morganroth. Calls attention to ingenious devices for making use of materials which would otherwise be wasted. 1700 w. Mines & Min—July, 1900. No. 35189 C.

Brown Coal.

Brown Coal Mining in the Rhineland. Information concerning the character of the deposits and methods of working. 1000 w. Jour Soc of Arts—June 22, 1900. No. 35085 A.

Classification.

The Chemical Classification of Coal. Clarence A. Seyler. Read before the So. Wales Inst. of Engs. A discussion of the methods of classification, giving views of writers of note, and examining the results of the graphic method, and data on which various classifications are based. 6000 w. Col Guard—July 6, 1900. Serial. 1st part. No. 35285 A.

Coal-Cutting.

On Coal-Cutting Machines in the United States. A. Bachellery. Read before the Min. & Met. Cong. at Paris. Brief account of the types in use. 1000 w. Ir & Coal Trds Rev—July 6, 1900. No. 35410 A.

Coal Supply.

The Coal Reserves at the Close of the Nineteenth Century. Edward Hull. Abstract of an address at meeting of Victoria Inst., London. Discusses the export of this mineral from England, and things in reference to the supply that should be investigated by the Royal Commission. 2000 w. Ir & Coal Trds Rev—July 20, 1900. No. 35619 A.

The Present Coal Crisis in Europe. Abstract of an article in the latest monthly summary of the Commerce and Finance

of the United States. Discusses the scarcity and price of coal and the causes. 3400 w. Ir & Coal Trds Rev—July 20, 1900. No. 35618 A.

Coke Ovens.

Semet-Solvay By-Product Coke Ovens. Brief paper read before the Brit. Inst. of Min. Engs. Illustrates and describes the plant at Wheeling, W. Va. 1200 w. Col Guard—June 22, 1900. No. 35116 A.

The Brunck Coke Oven. R. Brunck, in *Stahl und Eisen.* Describes this system and illustrates the newest large installation. 1700 w. Col Guard—July 13, 1900. No. 35509 A.

The Brunck Coke Oven System (Ueber Koksöfen System Brunck). Dr. R. Brunck. An illustrated description of the Brunck system, in which the heating of the two halves of the oven is entirely independent, the air is heated before reaching the coal, and provision is made for securing the by-products, tar, ammonia, benzol and illuminating gas. 1500 w. 1 plate. Stahl und Eisen—July 1, 1900. No. 35337 D.

Electricity.

Electricity in Collieries. Reviews its history, progress and present position, considering signalling, telephones, blasting and lighting. Ill. 6000 w. Col Guard—July 13, 1900. No. 35507 A.

Flooded Mine.

The Reopening of a Flooded Colliery. Charles Cooke. Extract from a paper in *The Journal of the British Society of Mining Students.* An account of a mine in the Lancashire coal field, once reopened, but again flooded, and still the water is flowing after seventeen years. 1500 w. Col Guard—July 6, 1900. No. 35288 A.

Ireland.

The Coal Fields of Ireland. Illustrates and describes the coal fields of Kilkenny and Tipperary, and the Connaught coal field. 3200 w. Col Guard—June 29, 1900. No. 35224 A.

Natal.

The Coal Deposits of Natal. An account of the character and quality of the deposits, with map. 900 w. Col Guard—June 22, 1900. No. 35115 A.

Paris Exhibition.

Coal Mining at the Paris Exhibition of 1900. Illustrated description of the mining exhibits of the different countries. 14000 w. Ir & Coal Trds Rev—June 29, 1900. No. 35220 A.

Safety Lamps.

Safety Lamps—Past and Present. Reviews the appliances used for lighting mines, illustrating many of the safety lamps. 3800 w. Ir & Coal Trds Rev—June 29, 1900. Serial. 1st part. No. 35219 A.

Surface Arrangements.

Colliery Surface Arrangements for the Delivery of Coal from Pit Cage into Railway Wagons, for a Gross Quantity of, Say, 1,500 Tons per Day, Exclusive of Coal Washing and Coking. S. A. Everett. Illustrated description of best arrangement suited to colliery conditions in South Wales. 5500 w. Can Min Rev—July 31, 1900. Serial. 1st part. No. 35670 B.

Surface Arrangements at a Belgian Colliery. M. C. Minsier. From *Annales des Mines de Belgique.* Illustrated description. 3000 w. Col Guard. June 22, 1900. No. 35118 A.

Wyoming, Pa.

Dangerous Outcrops Under Quicksand Deposits. From the report of G. M. Williams. Illustrates and describes deposits in the Wyoming basin in Pennsylvania, and the reasons why their working is exceedingly dangerous. 1400 w. Ir & Coal Trds Rev—July 13, 1900. No. 35498 A.

Ventilation.

See same title under Mining, below.

COPPER.

Chemistry.

The Chemistry of Copper. Charles Skeele Palmer. A discussion of the subject as viewed from the laboratory. 2500 w. Aust Min Stand—June 14, 1900. No. 35418 B.

Concentration.

Concentration of Ores by Petroleum. Charles M. Rolker. Read before the Mining Inst. Describes the important features of the Elmore process as practiced on copper rock, at Glasdir, Wales. 1800 w. Am Mfr & Ir Wld—June 28, 1900. No. 35099.

Copper Iron.

The Influence of Copper on Iron (Der Einfluss des Kupfers auf Eisen). W. Lipin. An account of the mechanical influence of a copper alloy in iron and steel, with the results of tests. Tables and illustrations. Serial. 2 parts. 5000 w. Stahl und Eisen—May 15, June 1, 1900. No. 35328 each D.

Production.

Copper Production and Consumption. Discusses the production, prices and consumption. 1600 w. Eng & Min Jour—July 21, 1900. No. 35461.

Queensland.

The Macarthur District. A Dewhurst Gore. Describes the silver and copper fields, and the development. 1800 w. Aust Min Stand—June 14, 1900. No. 35422 B.

Refining.

Further Notes on Elimination of Im-

purities from Copper in Refining and Converting. Edward Keller. Supplementary information to a previous paper. 900 w. Trans Am Inst of Min Engs—June, 1900. No. 35519 D.

Spanish Copper.

The Rio Tinto Mines. An interesting description of these great mines in Spain. 6000 w. Aust Min Stand—May 24, 1900. No. 35212 B.

Tasmanian Copper.

The Tasmanian Copper Company and the Phœnix Syndicate. Editorial comment on the history of this company, and cautioning against too much confidence in the promises made. 1700 w. Eng & Min Jour—July 7, 1900. No. 35162.

GOLD AND SILVER.

Bokhara.

Mining in Bokhara. W. Rickmers. Describes the method of working the gold-bearing conglomerates of Asiatic Russia. 800 w. Aust Min Stand—June 14, 1900. No. 35420 B.

British Columbia.

A Trip to Rossland, British Columbia. Arthur Lakes. An illustrated account of some of the mines and the peculiarities of the ores. Also a description of the geology of shearage-zone fissure veins and facts regarding extent of development. 4500 w. Mines & Min—July, 1900. No. 35193 C.

Mining in British Columbia. Official facts from the report of the Minister of Mines, relative to the mining industry, product during 1899, etc. 600 w. U. S. Cons Repts, No. 780—July 14, 1900. No. 35227 D.

Mount Sicker District, Vancouver Island. W. M. Brewer. Describes the copper deposits, the geology, and the development. 1800 w. Eng & Min Jour—July 21, 1900. No. 35462.

Progress on Vancouver and Texada Islands. W. M. Brewer. Shows the varied and important deposits, and the progress of development work. 1600 w. Eng & Min Jour—July 14, 1900. No. 35263.

British Guiana.

Gold Mining in British Guiana. John H. Powell. Read before the Inst. of Min. & Met., Lond. Part first describes the country and deposits and methods of mining. 2500 w. Aust Min Stand—June 14, 1900. Serial. 1st part. No. 35421 B.

Butte.

The Mines of Butte. Arthur Lakes. An account of the large bodies of copper ore and the crushing of timbers from the swellings of the walls; and a description of the formation and mines of the silver belt. Ill. 2500 w. Mines & Min—July, 1900. No. 35188 C.

Cape Nome.

Cape Nome, Alaska, Gold Region. Epitome of report by F. C. Schrader and A. H. Brooks, of the U. S. Geol. Surv. Concerning the formation of the country, and where and how the gold is found. Ill. 4300 w. Mines & Min—July, 1900. No. 35190 C.

Chloride.

The Chloride District, Arizona. Theo. B. Comstock. Much of the information given was gathered at the Elkhart mine and adjoining region. Gives an account of the development. 2700 w. Eng & Min Jour—July 28, 1900. No. 35544.

Cœur D'Alene.

Cœur D'Alene Mining Region. W. C. Clark. Facts in regard to the development of the country and the forms in which the minerals are found. 1800 w. Mines & Min—July, 1900. No. 35194 C.

Cripple Creek.

The Cripple Creek Volcano. T. A. Rickard. An illustrated explanation of the mining geology of this district and the method of formation. 9600 w. Trans Am Inst of Min Engs—June, 1900. No. 35-513 D.

Dawson.

Notes from Dawson; the Koyukuk Region. An estimate of the output of gold for this season, and other information. 450 w. U. S. Cons Repts, No. 774—July 7, 1900. No. 35153 D.

Dredging.

Gold Dredging in New Zealand. P. G. Morgan. Describes the alluvial deposits showing the conditions which led to this industry, giving the history of early attempts at dredging, and describing types of dredges used. Ill. 3200 w. Eng & Min Jour—Aug. 4, 1900. Serial. 1st part. No. 35700.

Gold Dredging at Oroville, Cal. H. G. Parsons. An account of the work, the types of dredges in use, etc. 1000 w. Min & Sci Pr—July 7, 1900. No. 35260.

Hydraulic Mining.

California Hydraulic Mining Under the Caminatti Act. Explains the manner of occurrence and gives illustrated description of methods of hydraulic mining used. The difficulties which led to the passage of this act are also explained. 3400 w. Sci Am Sup—July 21, 1900. No. 35424.

Peru.

The Santo Domingo Gold Mine in Peru. F. C. Fuchs. Illustrated description of the deposits and account of the working. 1800 w. Eng & Min Jour—July 7, 1900. No. 35164.

Placers.

Placer-Mining in the Southern Urals.

Charles Tappan. An account of the results of an examination of part of the South Ural Placer District. 3000 w. Eng & Min Jour—July 14, 1900. Serial. 1st part. No. 35264.

The Testing of Flat Placer Deposits. Robert Nye. Discusses usual methods of testing, and the proper use of a well driller. 2400 w. Eng & Min Jour—July 14, 1900. No. 35265.

Pockets.

Pocket Mining in Southern Oregon. W. I. Fleck. Describes pocket deposits, especially in this district, with information concerning the prospecting. 1200 w. Eng & Min Jour—July 21, 1900. No. 35463.

Pyrites.

The Extraction of Gold from Auriferous Pyrites by Amalgamation. Thomas G. Davey. Read before the Inst. of Min. & Met., London. On the merits of the pan-amalgamation process, giving illustrated description. Ill. 2500 w. Eng & Min Jour—July 28, 1900. No. 35546.

Veins.

The Enrichment of Gold and Silver Veins. Walter Harvey Weed. A synopsis of the writer's theory and an explanation of its application to deposits of the precious metals. Ill. 8000 w. Trans Am Inst of Min Engs—June, 1900. No. 35517 D.

True Fissure vs. Shearage-Zone Veins. Arthur Lakes. On the probability that the origin and method of formation of both are practically the same. 1800 w. Mines & Min—July, 1900. No. 35195 C.

IRON AND STEEL.

Anthracite-Iron.

Reminiscences of the Early Anthracite-Iron Industry. Samuel Thomas. Reviews the use, growth and development of anthracite coal in the manufacture of pig-iron. Ill. 7500 w. Trans Am Inst of Min Engs—June, 1900. No. 35514 D.

Basic Process.

Present State of the Basic Process. M. G. Rocour. From a paper prepared for the International Congress, Paris. Considers the great extension of the basic Bessemer process and the causes, and discusses the effect on the iron manufacture. 1100 w. Col Guard—July 13, 1900. No. 35508 A.

Bertrand-Thiel.

Further Notes on the Bertrand-Thiel Process. Joseph Hartshorne. Summary of a report on the operations at Kladno, with general information. 1600 w. Trans Am Inst of Min Engs—June, 1900. No. 35521 D.

Blast Furnace.

A New Kind of Blast Furnace Construction (Ueber eine Neue Hochofenconstruction). F. Burgers. A paper before the Verein Deutscher Eisenhüttenleute, giving an illustrated description of blast furnaces built almost entirely of iron, with only a thin lining of brick, and cooled by water flowing over the outside. Serial. 1st part. 1600 w. Stahl und Eisen—July 1, 1900. No. 35336 D.

Projects for the Mechanical Charging of Blast Furnaces (Vorschläge zur Mechanischem Beschickung von Hochöfen). F. W. Lürmann. Various plans for traveling cranes for conveying ore, coke and flux to the mouths of two or more furnaces. 500 w. 1 plate. Stahl und Eisen —June 1, 1900. No. 35329 D.

Elba.

The Iron Ores and Blast Furnaces of Elba. Information concerning the arrangements being made for the erection of blast furnaces on this island, and the iron ores. 1600 w. Ir & Coal Trds Rev—July 6, 1900. No. 35409 A.

Germany.

Changing Conditions in the German Iron and Coal Markets. A statement of the situation and showing the gravity of the competition which producers will have to meet. 1800 w. U. S. Cons Repts, No. 781—July 16, 1900. No. 35228 D.

Iron Trade.

Industrial Depressions and the Pig-Iron Reserve. Geo. H. Hull. Points out the difference between a panic, caused by low prices, and a depression, caused by high prices, and presents statistics showing a close connection between abnormal prices for iron and reasons of great depression. Proposes reduction of iron prices and the creation of a reserve supply as efficient means for recovering stability. 7000 w. The Engineering Magazine—Aug., 1900. No. 35631 B.

Magnetic Ores.

Some Points in Connection with the Composition of Iron Ores. Part first deals with peculiarities of the magnetic ores. 2000 w. Col Guard—July 6, 1900. Serial. 1st part. No. 35282 A.

Nova Scotia.

The Iron Ores of Nova Scotia. George B. Cowlam. Describes new discoveries of magnitude and economic importance. 1500 w. Col Guard—July 20, 1900. No. 35624 A.

Recalescence.

The Theory of the Iron-Carbon Alloys, According to Osmond and Roberts-Austen (Die Theorie der Eisen-Kohlenstofflegirungen nach Osmond und Roberts-Austen). E. Heyn. An illustrated review of the work of Osmond and Roberts-Austen and others on iron-carbon alloys. Cooling-off curves are given and points of recalescence

shown. 5500 w. Stahl und Eisen—June 15, 1900. No. 35332 D.

Slag.

The Determination of Slag in Iron and Steel (Die Bestimmung der Schlacke im Eisen und Stahl). Leopold Schneider. A description of methods of analysis. Serial. 2 parts. 3500 w. Oest Zeitschr f Berg u Hüttenwesen—May 19, 26, 1900. No. 35353 each B.

Specifications.

Specifications for Iron and Steel Work in Buildings. Maurice M. Sloan. Gives a sample specification. 4500 w. Am Archt —June 30, 1900. No. 35097.

Steels.

The Analysis of Chrome and Tungsten Steels. A. G. McKenna. Explains satisfactory methods used by the writer. 1000 w. Pro Engs' Soc of W Penna—April, 1900. No. 35429 D.

The Manufacture of Special Steels. L. Babu. Condensed from a paper read before the Met. Cong. at Paris. The critical points of special steels are discussed and their manufacture. 2500 w. Ir Trd Rev —July 19, 1900. No. 35426.

Sweden.

Some Little Known Iron Ore Deposits in Northern Sweden (Ueber einige Weniger Bekannte Eisenerz vorkommen im Nördlichen Schweden). Otto Vogel. An article, founded on Swedish official reports, describing the location of ore beds and giving analyses of ores, with tables and map. Serial. 2 parts. 1 plate. 5000 w. Stahl und Eisen—May 15, June 1, 1900. No. 35327 each D.

Sweden's Exhibit of Iron Manufactures at Paris (Die Pariser Weltausstellung. V. Schwedens Eisenindustrie-Austellung). A general account of the Swedish iron mining and metallurgical exhibit. 1000 w. Stahl und Eisen—June 15, 1900. No. 35333 D.

Thomas Steel.

See Civil Engineering, Bridges.

MINING.

Accidents.

The Red Ash Mine Disaster. James W. Paul. A description of the mine and conditions existing before the accident. 3200 w. Mines & Min—July, 1900. No. 35191 C.

Assessments.

The Assessment of a Coal Mine for Income Tax. Gives cases illustrating English law. 2200 w. Col Guard—July 6, 1900. No. 35283 A.

China.

Metal Mining in China. Herbert C. Hoover. Paper read before the Inst. of Min. & Met., London. Concerning the geography, geology and history of metal mining in the provinces of Chi-li and Shantung. Copper, gold and silver ore found and native methods of mining described. 3000 w. Aust Min Stand—June 7, 1900. No. 35416 B.

The Present Position of Mining in China (Die Gegenwärtige Lage des Bergbaues in China). Paul Speier. A list of the principal mining concessions to foreign companies, with some of the Chinese regulations governing concessions. 800 w. Glückauf—July 7, 1900. No. 35352 B.

Concentrating.

The Avino Mine, Mexico. Illustrates and describes the effective concentrating plant and the mine. 1600 w. Aust Min Stand—June 7, 1900. No. 35417 B.

Deep Mines.

Some Problems in Deep Coal Mining. H. M. Chance. Discusses the difficulties encountered and the systems for overcoming them. 1300 w. Jour Fr Inst—Aug., 1900. No. 35594.

Means for Counteracting High Temperatures in Deep Mines. Léon Poussigue. From a paper prepared for the International Cong. at Paris. States the prevailing conditions, and discusses the points needing attention, the use of fans, etc. Ill. 3500 w. Col Guard—June 29, 1900. No. 35225 A.

I. On the Working Conditions in Mines of Great Depth in Belgium. Simon Stassart. II. On the Working of Deep Mines. Joseph Hrabak. Two papers read at Min. & Met. Cong. in Paris. The first considers five of the deepest collieries in Belgium. The second considers winding arrangements. 2400 w. Ir & Coal Trds Rev —June 29, 1900. No. 35218 A.

Electric Appliances.

On the Employment of Electricity in Mines. Joseph Libert. Read before the Min. & Met. Cong. at Paris. Abstract. Information concerning the current most largely used, the applications, etc. 1200 w. Ir & Coal Trds Rev—July 6, 1900. No. 35411 A.

Electric Haulage at the Eureka Mines, Windber, Penn. A. S. M'Allister. Illustrated detailed description of the plant and power applications. 2500 w. Am Elec't'n—July, 1900. No. 35177.

See also Electrical Engineering, Mining Machinery.

Explosives.

The Explosives Industry in 1899. Interesting particulars from the annual report of H. M. inspectors of explosives. 2400 w. Col Guard—July 20, 1900. No. 35620 A.

The Testing of Explosives for Mining Purposes. M. B. Lloyd. Report on the working of the British Government Testing Station for Explosives, for the year

1899. 3000 w. Col Guard—July 20, 1900. No. 35622 A.

Use of Safety Explosives. M. Delafond. From a paper prepared for the International Cong. at Paris. On the advances due to the investigations of the French Firedamp Commission. 1800 w. Col Guard—June 29, 1900. No. 35226 A.

Automatic Door for Underground Stores for Explosives. J. Jicinsky, in *Oesterreichische Zeitschrift für Berg-und Hüttenwesen.* Illustrates and describes a closing device used in Austria and approved by mining officials. 1000 w. Col Guard—July 20, 1900. No. 35623 A.

Comparative Blasting Tests with Dynammon No. 1 and Compressed Blasting Powder Cartridges (Vergleichende Sprengversuche mit Dynammon Nr. 1 und Comprimirten Sprengpulverpatronen). S. Heyda. An account of experiments in a salt mine with dynammon, a safety explosive consisting principally of ammonium nitrate, and blasting powder; with tables. 3200 w. Oest Zeitschr f Berg u Hüttenwessen—May 26, 1900. No. 35354 B.

Self-Closing Door for Underground Magazine for Explosives (Selbstthätiger Abschluss für Unterirdische Sprengmittelmagazine). J. Jicinsky. An illustrated description of an automatic door of a small magazine in a coal mine in Austria. 1 plate. 800 w. Oest Zeitschr f Berg u Hüttenwesen—July 7, 1900. No. 35360 B.

Hydrography.

Hydrographic Investigations of the U. S. Geological Survey in Their Relation to Mining. F. H. Newell. Explains the manner of carrying on these investigations and their value. Ill. 3000 w. Trans Am Inst of Min Engs—June, 1900. No. 35522 D.

Igniter.

Safety Shot Igniter. Illustrated description of a French device by which a fuse may be safely fired in a gassy mine. 1300 w. Mines & Min—July, 1900. No. 35192 C.

Mine Pump.

An Underground Pump at the Preussen I. Mine (Unterirdische Wasserhaltungsmaschine der Zeche Preussen I.). F. Schulte. An illustrated description of a compound Corliss steam pump, of novel construction. 2 plates. 1200 w. Glückauf—May 19, 1900. No. 35347 B.

Mining Conditions.

Mines and Miners. Reviews conditions in the British Isles previous to the reign of Queen Victoria, and the reports and evidence furnished by the Royal Commission, which led to legislation for bettering the condition of the miner and his child. 3400 w. Engng—July 20, 1900. Serial. 1st part. No. 35570 A.

Ore-Deposits.

The Secondary Enrichment of Ore-Deposits. S. F. Emmons. A statement of the writer's belief and argument sustaining it. 15700 w. Trans Am Inst of Min Engs—June, 1900. No. 35518 D.

Origin and Classification of Ore-Deposits. Charles R. Keyes. Considers the basis of classification and presents the scheme which commends itself to the writer. 10000 w. Trans Am Inst of Min Engs—June, 1900. No. 35512 D.

Some Principles Controlling the Deposition of Ores. C. R. Van Hise. A statement of the principles, and an explanation of their application to ore deposits, and their classification. 54000 w. Trans Am Inst of Min Engs—June, 1900. No. 35516 D.

Safety Lamps.

The Testing Station for Safety Lamps at Bismarck, Westphalia (Die Versuchsstation für Sicherheitslampen auf der Berggewerkschaftlichen Versuchsstrecke bei Bismarck i. W.). H. Fähndrich. An illustrated description of the apparatus and methods of testing. 2 plates. 2600 w. Glückauf—May 26, 1900. No. 35348 B.

Shaft Sinking.

Sinking a Shaft Through a 6.7-Meter Layer of Quicksand at a Depth of 155.5 Meters at Sollenau, Lower Austria (Durchteufung des 6.7m Mächtigen Schwimmsandes am Sollenauer Schachte Nr. 1, bei 155.5 m Teufe). K. Hoftich. An illustrated description of the work, in which a combination of methods was used, with costs. 1 plate. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—June 9, 1900. No. 35355 B.

Sinking Through Quicksand at an Austrian Colliery. K. Hoftich, in *Oesterreichische Zeitschrift für Berg-und Hüttenwesen.* Illustrates and describes the method adopted, which employed a wrought-iron caisson made of 2/5 in. plate, driven into the quicksand. 1300 w. Col Guard—June 22, 1900. No. 35119 A.

Soudan.

Mining Ordinance in the Soudan. A copy of the Mining Ordinance of 1899. 1400 w. N. Z. Mines Rec—May 16, 1900. No. 35210 B.

United States Minerals.

The Work of the United States Geological Survey in Relation to the Mineral Resources of the United States. Charles D. Walcott. An outline of what has been and is being accomplished by the Survey, with map. 7500 w. Trans Am Inst of Min Engs—June, 1900. No. 35520 D.

Ventilation.

A Combined Exhaust and Blast Fan for Colliery Ventilation. Illustrated description with a statement of the advan-

tages of such fans. 900 w. Col Guard—July 6, 1900. No. 35284 A.

Composition of Mine Atmosphere. From a paper by Prof. Kotsowsky, prepared for the International Cong. at Paris. Concerning investigations made in Russia, and the results, Russian mine regulations, etc. 2300 w. Col Guard—July 20, 1900. No. 35621 A.

Wages.

Piece Rates of Miners' Wages and Sliding Scales. From a report on Standard Piece Rates of Wages and Sliding Scales in the United Kingdom. 1500 w. Col Guard—July 13, 1900. No. 35510 A.

Winding.

Winding from Great Depths. Léon Poussigue. From a paper for the International Congress at Paris. Discusses various systems for deep winding, and the most practical solution of the problem. Ill. 5500 w. Col Guard—July 6, 1900. No. 35287 A.

MISCELLANY.

Aluminothermie.

The Process of Generating High Temperatures by the Combustion of Aluminium with some Technical Applications Thereof (Verfahren zur Erzeugung Hoher Temperaturen durch Verbrennen von Aluminium und einige Anwendungen desselben in der Technik). Dr. Hans Goldschmidt. An illustrated account of the author's process for generating high temperatures by burning aluminium, with many applications, such as welding and repairing, and obtaining chemically pure metals. 4000 w. Glückauf—June 2, 1900. No. 35349 B.

Bosnia-Herzegovina.

Mining and Metallurgy in Bosnia and Herzegovina in 1899 (Das Berg-und Hüttenwesen in Bosnien und der Hercegovina im Jahre, 1899). General statistics, with tables. 1200 w. Oest Zeitschr f Berg u Hüttenwesen—June 30, 1900. No. 35359 B.

Fire Brick.

On Various Kinds of Fire Brick used in Germany (Ueber Verschiedene im Handel befindliche Chamottesteine). H. Hect, H. Leger and E. Cramer. A comparison of various German and foreign refractory bricks, with table giving chemical composition, specific gravity, resistance to heat and other data. 1500 w. Stahl und Eisen—June 15, 1900. No. 35334 D.

German Exhibit.

The German Metallurgical Exhibit at the Paris Exposition (Die Pariser Weltausstellung IV. Von der Deutschen Ausstellung für Hüttenwesen (Klasse 64). An illustrated account of some of the exhibits in the German section of the metallurgical department at the Paris Exposition. 1000 w. Stahl und Eisen—June 1, 1900. No. 35331 D.

Haiti.

Mineral Resources of Haiti; Railways. On the need of transportation facilities, and the mineral wealth of the island. 1000 w. U. S. Cons Repts, No. 783—July 18, 1900. No. 35289 D.

Lead.

The Lead Mines of Southeastern Missouri. Interesting information concerning the deposits of this district, the mining and concentration. 1800 w. Eng & Min Jour—July 28, 1900. No. 35543.

Metal.

The Nature and Yield of Metalliferous Deposits. Bennett H. Brough. Describes the principal ore-deposits of the world. Ill. 8300 w. Jour Soc of Arts—July 20, 1900. No. 35581 A.

Mica.

Mica and Mica Deposits. J. Ohly. Considers the peculiarities of mica and its demand, giving information regarding its preparation for market, etc. 1700 w. Min Rept—July 12, 1900. No. 35296.

Ore Shipping.

The Control of Lake Ore Shipping. Waldon Fawcett. Discusses the elements of strength held by the Rockefeller and other ore-moving interests. 1600 w. Am Mfr & Ir Wld—July 26, 1900. No. 35549.

Ozokerite.

Ozokerite. J. Ohly. Information where this mineral is found and account of the only two mines of any magnitude. 2200 w. Min & Sci Pr—July 7, 1900. No. 35261.

Paris Exhibition.

Mining and Metallurgical Exhibits at the Paris Exposition. Description of the exhibits, with a few illustrations. 3200 w. Eng News—July 19, 1900. No. 35441.

Philippines.

Prospecting in the Philippines. G. D. Rice. Reports plenty of metals, but must be developed at considerable cost. 1800 w. Am Mfr & Ir Wld—July 26, 1900. No. 35600.

Phosphate.

The American Phosphate Company's Plant Near Mount Pleasant, Tenn. George F. Blackie. Abstract of paper read before the Engng. Assn. of the South. Illustrates and describes the plant and its operation. 2000 w. Eng & Min Jour—July 7, 1900. No. 35163.

Quicksilver.

The Terlingua Quicksilver Mining District, Brewster Co., Texas. H. W. Turner. Brief account of the deposits, with

illustration of a retort. 800 w. Min & Sci Pr—July 21, 1900. No. 35511.

Smelting.

Smelting in Durango, Mexico. H. Van F. Furman. Describes the ores and the method used. 1700 w. Aust Min Stand—June 14, 1900. No. 35419 B.

Zinc-Lead.

The Missouri-Kansas Zinc and Lead Mines. Harold A. Titcomb. An account of the development, with description of the ore bodies, ore treatment, etc. Ill. 1500 w. Eng & Min Jour—July 28, 1900. No. 35545.

Zinc.

The Purchase of Zinc Ores in the Joplin District. W. George Waring. Considers the selling of zinc ores on an assay basis the only rational system. 1500 w. Eng & Min Jour—July 14, 1900. No. 35266.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in May. The detailed list and classified summary of train accidents for the month. 4000 k. R R Gaz—July 6, 1900. No. 35145.

Cost.

The Comparative Cost of Rail and Water Transportation in Europe. Information from important treatises of European engineers of high standing, giving facts regarding foreign costs of transportation. 2800 w. Eng News—July 19, 1900. No. 35439.

London Railways.

The Future of London Railways. G. F. Millin. Discusses the changes to the advantage of London, made possible by the inventions of the electric light, the use of electricity for light and traction, and the Greathead shield. 4200 w. Contemporary Rev—July, 1900. No. 35448 D.

Quarantine.

The Practical Phases of Quarantine as It Affects Railroads. A. W. Sullivan. Read before the International Assn. of Ry. Surgeons. Reviews the conditions and regulation of traffic, and discusses its value and effect from a railroad point of view. 3300 w. Ry Age—July 20, 1900. No. 35470.

Resistance.

Some Notes on Train Resistance. T. Lester Daniel. Considers the advantages to be gained by reducing resistance, and gives results obtained from a dynamometer car test, etc. 1500 w. N-W Ry Club—May, 1900. No. 35539 C.

Train Rules.

Superior Extras vs. Scheduled Trains—Proposed Rules. J. F. Mackie. Discusses proposed rules for the Can. Pacific Ry., and offers some suggestions. 1700 w. Ry Age—July 20, 1900. No. 35471.

FINANCIAL.

Railway Statistics.

Statistics of Railways in the United States for the year ending June 30, 1899. Information from the twelfth report of the Interstate Commerce Commission. 2400 w. Ry & Engng Rev—July 14, 1900. No. 35267.

MOTIVE POWER AND EQUIPMENT.

Axle Loads.

The Increase of Loads on Railway Cars (Die Erhöhung des Achsdruckes an Eisenbahnfahrzeugen). Rudolf Sanzin. A plea for increasing the loads on cars and locomotives in Central Europe so as to promote economy in transportation, with table of axle loads in Europe and America. 2000 w. Zeitschr d Oest Ing u Arch Ver—May 18, 1900. No. 35340 B.

Brake Beams.

Brake Beam Pressure. E. C. Schmidt. Describes experiments made by the Univ. of Illinois. Also an editorial. Ill. 2500 w. R R Gaz—July 27, 1900. No. 35603.

Cars.

New Parlor Cars. Illustrated description of the interior of two fine parlor cars in service on the C., M. & St. P. Ry. 600 w. Ry Age—June 29, 1900. No. 35123.

Coke.

Coke Burning in France. George L. Fowler. Facts regarding the work done in burning coke on foreign railroads. 700 w. R R Gaz—July 20, 1900. No. 35446.

Doors.

Grain Doors. H. C. Barnard. Read before the Cent. Assn. of R. R. Officers, Louisville, Ky. Reviews the doors which have been used, discussing their objections. 1100 w. St. Louis Ry Club—July 13, 1900. No. 35451.

Draft Appliances.

Draft Appliances of Extension Front. Thomas P. Whelan. Discusses the steaming qualities of engines, as affected by management of the draft appliances. 1800 w. Loc Engng—Aug., 1900. No. 35578 C.

Freight Cars.

Capacity of Freight Cars. Short ab-

stract of a report by Mr. de Marx, traffic manager of the Hungarian State Railroads. 450 w. R R Gaz—July 13, 1900. No. 35270.

Wooden Box Cars and Coal Cars of 100,000 lbs. Capacity; Southern Pacific Ry. Two-page plate with description and dimensions. 4200 w. Eng News—July 19, 1900. No. 35438.

The Most Economical Size of Freight Cars. L. F. Loree. Paper prepared for the International Ry. Cong. Abstract. Showing the advantages gained by the use of large capacity cars. 1600 w. R R Gaz—July 6, 1900. No. 35144.

Locomotive Practice.

Recent Locomotive Practice in France. M. Edouard Sauvage. Information concerning the seven great railway lines of France. Considers compound locomotives with four cylinders, other locomotives, and various details of construction. Ill. 6400 w. Inst of Mech Engs—1900. No. 35-199 D.

Locomotives.

A New Compound Locomotive. John Rickie. Describes an improved system of using steam expansively, appliable to all engines, but especially suitable to locomotive, electric light, and other engines which have to deal with variable loads. 2300 w. Engr, Lond—July 20, 1900. No. 35627 A.

The Pennsylvania's Class E-2 Experimental Locomotive. Outline drawing and description. 600 w. R R Gaz—July 20, 1900. No. 35443.

Richmond 10-Wheeled Locomotives—Finland State Railroads. Illustrations and descriptive specifications. 400 w. R R Gaz—July 6, 1900. No. 35143.

Rational Firebox Passenger Locomotive, C. & N. W. Ry. Illustration with description and comments. 1400 w. Ry & Engng Rev—July 28, 1900. No. 35617.

Report of Committee on Compound Locomotives. Abstract of a report presented by a committee of the Am. Ry. Mas. Mechs.' Assn. 2800 w. Eng News—July 5, 1900. No. 35187.

A Single-Wheeled Bogie Express Passenger Engine—Great Central Railway. Drawings and description. 1500 w. R R Gaz—July 27, 1900. No. 35604.

Four-Coupled Express Passenger Locomotive; Great Northern Railway Company (Ireland). Illustrations with brief description. 350 w. Engng—July 6, 1900. No. 35279 A.

Geared Locomotive for the McCloud River Railroad. Briefly describes this Californian road and gives illustrated description of the 60-ton Heisler geared locomotive. 1500 w. Engng—July 20, 1900. No. 35572 A.

Single-Expansion Engines with Piston Valves—State Railroad of France. M. Desdouits. From *Revue Générale des Chemins de Fer.* Abstract giving illustrations and principal dimensions, and a comparison of results with compound engines. 2700 w. R R Gaz—July 13, 1900. No. 35-269.

A Rebuilt Reading Locomotive. Illustrates and describes a Phila. & Reading engine, rebuilt by S. M. Prince, Jr., Supt. of motive power and rolling equipment. The boiler was raised to admit the change of wheels from 68½ to 78 in. in diameter. Wheel center is of cast-steel, and is cast solid. Cylinder fastenings are also novel, being entirely without bolts. 600 w. Loc Engng—Aug., 1900. No. 35576 C.

Paris Exposition.

Railway Rolling Stock at the Paris Exposition. Comments on the exhibits and regrets that American practice is not adequately represented. 4200 w. Eng News—July 5, 1900. No. 35184.

The State Railways of France at the Paris Exhibition. Illustrates and describes the exhibits of the Administration of State Railways in France. 2200 w. Engng—July 6, 1900. Serial. 1st part. No. 35-278 A.

Rating.

Some Observations on the Tonnage Rating of Engines. C. C. Riley. Extracts from a paper prepared for the July meeting of the Cent. Assn. of R. R. Officers. Discusses the lack of uniformity, the real object of tonnage rating, and the ideal method of engine rating. 3000 w. R R Gaz—July 20, 1900. No. 35442.

Rolling Stock.

The Advantages to Be Gained by Selecting Rolling Stock for a Given Service. Douglas T. Heap. Explains the traffic arrangements on the Waterloo and City Ry., England, and the alterations made by a service of single cars. 1000 w. Tram & Ry Wld—July 5, 1900. No. 35488 A.

Tires.

The Hönigsvald Method of Fastening Tires on Car Wheels (Ueber die Directe Radreifenverbindung (Patent Hänigsvald) vom Standpunkte der Technologie des Eisens). Albert Sailler. Abstract of an address before a branch of the Oest. Ing. und Arch. Verein, giving an illustrated description of a method in which the tires are partly pressed and partly shrunken on to the wheel. 1600 w. Oest Zeitschr f Berg u Hüttenwesen—June 30, 1900. No. 35358 B.

Train Lighting.

Oil Engines for Train Lighting. Alton D. Adams. Suggests a plan for lighting trains by electricity, using an oil engine and a dynamo in each car. Also editorial comment. 2700 w. R R Gaz—July 20, 1900. No. 35447.

Train Lighting. George D. Shepard-

son. Discusses the sources of lights, results produced and cost, but gives the greatest attention to the illumination of passenger cars. Ill. 8400 w. N W Ry Club—May, 1900. No. 35538 C.

See also Electrical Engineering, Lighting.

NEW PROJECTS.

Austro-Hungary.

The Causes and Effects of the Unequal Development of the Railways in Germany and Austro-Hungary (Ursachen und Wirkungen der Ungleichartigen Entwicklung des Eisenbahnwesens in Deutschland und in den Ländem der Oesterr.-Ungar. Monarchie). Carl Büchelen. A general historical review, and discussion of the present situation, with map and tables. 1 plate. 10000 w. Zeitschr d Oest Ing u Arch Ver—June 29, 1900. No. 35345 B.

China.

China in Regeneration. An Epoch and an Opportunity. John Foord. Considers the existing crisis as the birth of a new Chinese government, on a progressive basis, and reviews the enterprises already under way, especially the railway concessions. 2700 w. The Engineering Magazine—Aug., 1900. No. 35632 B.

The Railways of China. Information concerning the lines opened or being built, the style of rail used, and the equipment, with remarks on projected railways. 4000 w. Ir & Coal Trds Rev—July 13, 1900. No. 35499 A.

Improvements.

Railway Improvements in Formosa. Describes the very poor transportation facilities, and gives an account of a proposed line that will be a benefit to North Formosa. 1200 w. U. S. Cons Repts, No. 789—July 25, 1900. No. 35482 D.

Incline Railway.

Machinery for the Garesfield and Derwenthaugh Incline Railway. Illustrated description of the hauling plant for the road named. 1500 w. Engng—July 13, 1900. Serial. 1st part. No. 35501 A.

Military Railroads.

Roads and Railways in Military Operations (Ueber Strassen und Eisenbahnen im Aufmarsch-und Operationsraum eines Heeres. Tertiärbahnen für den Localverkehr als Kriegsbahnvorrath). Col. Tilschkert. A paper before the Verein f. d. Förderung d. Local und Strassenbahnwesens, advocating stone tracks with automobiles, and other auxiliary means of transportation. 6000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—May, 1900. No. 35379 D.

New Zealand.

A Mountain Railway in New Zealand. A. P. Godber. Illustrated description of the Rimutaka Incline, and its equipment. 1000 w. Loc Engng—Aug., 1900. No. 35575 C.

Paris.

The New Lines of the Western Railway in Paris and its Vicinity (Die Neuen Bauten der Französischen Westbahn in Paris und Umgebung). E. A. Ziffer. Paper before the Verein f. d. Förderung d. Local u. Strassenbahnwesens describing the various improvements by which the railroad now reaches the Esplanade des Invalides, with maps and illustrations. 1 plate. 5000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—June, 1900. No. 35381 D.

PERMANENT WAY AND BUILDINGS.

American Rails.

Iron and Steel Rails in America. Robert W. Hunt. Read at London meeting of Am. Soc. of Civil Engs. Reviews the history of rail-making and railroad building, giving interesting information. 6000 w. Engng—July 6, 1900. Serial. 1st part. No. 35281 A.

Ballast.

Ballast. A. Feldpauche. Abstract of a report to the International Railroad Congress on the properties of good ballast, choice to be made between ballast of different qualities, etc. 2200 w. R R Gaz—July 13, 1900. No. 35268.

Crossings.

Highway Crossing Alarms. J. S. Evans. Read at Detroit, before the Assn. of the Ry. Tel. Supts. Discusses automatic alarms, and the requirements for protection of crossings. 1200 w. R R Gaz—July 20, 1900. No. 35444.

Paris.

Work on the Courcelles-Passy Section of the Line from Courcelles to the Champs de Mars (Ligne de Courcelles au Champ-de-Mars, à Paris. Travaux de la Partie Comprise entre Courcelles et Passy.) A. Dumas. A very fully illustrated description of improvements made by the Western Railway on this section of its Paris terminal lines. 2 plates. 5000 w. Génie Civil—July 7, 1900. No. 35394 D.

Rail Joints.

Rail Joints, Particularly Those on Street Railways (Der Schienenstoss, Insbesondere bei Strassenbahnen). Phil. Fischer. An account of improvements in rail joints, with many illustrations showing sections of rails made by the Phœnix Company of Laar. 1300 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—May, 1900. No. 35380 D.

Some Notes on Rail Joint Fastenings. F. C. Schmitz. Outlines the history of the angle-bar joint, and a discussion of its constructive features. Ill. 3800 w. R R

Gaz—July 27, 1900. Serial. 1st part. No. 35602.

Renewal.

Maintenance of Way. Abstract of reports of F. Tettelin and L. A. Denys, to the International R. R. Congress, on systems for maintenance and renewal of permanent way on lines of heavy traffic so as to avoid slackening speed of trains. 1800 w. R R Gaz—July 13, 1900. No. 35272.

Signaling.

Remarkable Progress in Signaling. Editorial review showing the varied character of the enterprise and expansion during recent years. 2500 w. R R Gaz—July 27, 1900. No. 35605.

Signals.

Signal Device for Mines. C. S. Herzig. Illustrated description of apparatus designed for a mine in Mexico. 1000 w. Trans Am Inst of Min Engs—June, 1900. No. 35523 D.

Station.

New Passenger Station at Richmond, Virginia. Illustrates and describes a union station in process of construction. 700 w. R R Gaz—July 13, 1900. No. 35271.

The Designing and Planning of Small Railroad Stations. Alfred Hoyt Granger. Discusses the requirements of town or country stations, giving many illustrations of recent work. 700 w. Br Build—July, 1900. No. 35524 C.

Steel Rails.

The Deterioration of Steel Rails. Editorial review of the report of a committee appointed by the British Board of Trade "to inquire what extent of loss of strength in steel rails is produced by their prolonged use on railways under varying conditions, and what steps can be taken to prevent the risk of accidents arising from such loss of strength." 3000 w. Engng—July 13, 1900. No. 35503 A.

Steel Ties.

Steel Ties on the Huntingdon & Broad Top Mountain R. R. Illustrated description of a form of steel tie which has been in experimental service for about six months. 800 w. Eng News—July 19, 1900. No. 35436.

Track Deformation.

Apparatus of M. Vassioutinsky for Registering Temporary Deformations in Railway Superstructures (Appareil de M. Vassioutinsky pour Enregistrer les Déformations Temporaires des Superstructres des Voies Ferrées). Translation from the Russian, describing a modification of the Ast apparatus for recording irregularities in the track. Illustrated. 1200 w. Bull de la Soc d'Encour—May 31, 1900. No. 35567 G.

TRAFFIC.

Rates.

Railway Rates and Charges for Electrical Machinery and Apparatus. Discusses the high rates for the transportation of this class of merchandise charged in England. 1500 w. Elec Rev, Lond—July 13, 1900. No. 35480 A.

STREET AND ELECTRIC TRAMWAYS

Alexandria.

The Tramway System of Alexandria (Le Réscau de Tramways de la Ville D'Alexandrie). T. Pollatcheck. A brief general description of the electric railway generating station and a few words about the line and rolling stock. 1000 w. Electricien—May 26, 1900. No. 35553 B.

American Practice.

Impressions of American Tramway Practice. A. E. Le Rossignol. Read at the Cardiff convention of the Munic. Elec. Assn. Impressions from a recent visit, with remarks on New York tramways. 2500 w. Elec Eng, Lond—July 20, 1900. No. 35586 A.

Austria.

Statistical Tables of the Austrian Local Railways for 1898 (Uebersichts-Tabellen Zusammengestellt aus der Statistik des Verbandes der Oesterreichischen Localbahnen für das Jahr 1898.) General engineering and financial statistics of 32 roads. 2000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—June, 1900. No. 35382 D.

Buenos Aires.

The Electric Lighting and Tramways of Buenos Aires. An illustrated detailed description. 2200 w. Elec Rev, Lond—July 13, 1900. Serial. 1st part. No. 35477 A.

Central London Ry.

The Central London Railway. A brief account of the opening and notice of the interesting features. 2000 w. Builder—June 30, 1900. No. 35211 A.

The Central London Railway. Editorial on the opening and operating of the electric railway. 2300 w. Engng—June 29, 1900. No. 35222 A.

The Central London Underground Railway. The first of a series of articles describing and illustrating this urban railway undertaking. 3000 w. Elec Wld & Engr—July 21, 1900. Serial. 1st part. No. 35464.

Como.

The Electric Tramway in Como. Illustrates and describes a line of novel construction, carried out in short time. A temporary concession granted to furnish transit for those visiting the Volta Exhibition. 1200 w. Tram & Ry Wld—July 5, 1900. No. 35491 A.

Corrosion.

Conditions of Electrolytic Corrosion in Brooklyn. Samuel Sheldon. An account of investigations carried out to determine the cause of the apparent immunity of cast iron in this extensive district. 2200 w. Trans Am Inst of Elec Engs—May, 1900. No. 35230 D.

Electric Traction.

Cost and Limitation of Electric Vehicle Traction. Alton D. Adams. Considers the cost of energy as furnished by the horse and by the steam engine, showing the cost of horse power to be about eleven times that of electric power, with much greater limitation. 2000 w. Sci Am—July 28, 1900. No. 35531.

Notes on Electric Traction Under Steam Railway Conditions. Edward C. Boynton. Discussions of this paper in New York and Chicago, and also a communication from M. H. Gerry, Jr. 12400 w. Trans Am Inst of Elec Engs—May, 1900. No. 35229 D.

Where Electric Traction Is Badly Needed. Editorial calling attention to the need of equipping the tunnels through which trains pass to and from the Grand Central Station in New York with electricity. 1100 w. Elec Rev, N. Y.—July 25, 1900. No. 35540.

Electrolysis.

Electrolysis of Underground Metal Structures. Dabney H. Maury. Condensed paper read before the Am. Water Works Assn., at Richmond, Va. Gives interesting experiments, and emphasizes the fact that the responsibility rests with the street railway companies. Ill. 5800 w. Eng News—July 19, 1900. No. 35437.

Electromagnets.

The Design of Tractive Electromagnets. W. Elwell Goldsborough. On the best methods in the design of this class of electromagnets. Mathematical. Ill. 7000 w. Elec Wld & Engr—July 28, 1900. No. 35601.

Elevated Roads.

Electric Traction "Not Entirely Satisfactory" for Elevated Railroads. Editorial on electricity as a motive power on elevated railroads. 800 w. Loc Engng—Aug., 1900. No. 35579 C.

Gauge.

On the Choice of a Gauge for Local Railways and Tramways (Ueber die Wahl der Spurweite für Lokal-und Trambahnen). A. Trautweiler. A consideration of the gauge question, with a discussion of the advantages and disadvantages of a narrow gauge. Serial. 1st part. 2400 w. Schweiz Bauzeitung—July 7, 1900. No. 35365 B.

Light Railways.

The Work of the Light Railway Commission. R. H. Scotter. Read at meeting of the Tram. & Light Rys. Assn. Reviews the history of the movement in England and the work of the commission, with suggestions. 2500 w. Engr, Lond—July 6, 1900. No. 35415 A.

London.

Overhead Electric Tramways for London. J. Clifton Robinson. History, illustrated description and argument. 10600 w. Tram & Ry Wld—July 5, 1900. No. 35486 A.

Paris.

Local Transportation at the Paris Exposition. Henry Harrison Suplee. Discusses the problems of city-traffic and describes the solution found in connection with the Exposition, especially the travelling sidewalk. Ill. 2600 w. The Engineering Magazine—Aug., 1900. No. 35635 B.

Electric Traction on the Extension of the Orleans Railway in Paris (La Traction Electrique sur le Prolongement de la Ligne D'Orleans dans Paris). J. A. Montpellier. A general description of the electrical equipment of this line along the Seine from the Place Valhubert to the Quai d'Orsay. 1200 w. Electricien—June 2, 1900. No. 35556 B.

Mechanically Operated Tramways in Paris (Die Bahnen mit Mechanischem Betrieb in Paris). An illustrated account of the different systems in use. Serial. 3 parts. 6000 w. Ill. Zeitschr f Klein u Strassenbahnen—June 1, 16, July 1, 1900. No. 35383 each C.

Polyphase.

Polyphase Electric Traction. C. A. Carus-Wilson. Read before the Inst. of Mech. Engs. Deals with this system and its application to railways, with illustrations from the Burgdorf Ry. in Switzerland, in part first. 3000 w. Engng—July 20, 1900. Serial. 1st part. No. 35574 A.

Power House.

See Electrical Engineering, Generating Stations.

Profits.

Profits on Tramway Undertakings. C. H. Gadsby. Read before the Tramways and Light Railways Assn., at Islington. Favors the electric equipment of tramways, showing that it increases the difference between gross receipts and work-

ing expenses. 2500 w. Elec Rev, Lond—July 13, 1900. No. 35478 A.

Railway Exhibition.

The International Tramways and Light Railways Exhibition, 1900. Concerning the large display of electric traction plant now on view at the exposition at Islington, England. 5500 w. Engng—June 29, 1900. No. 35223 A.

Snowdon Ry.

The Mechanical Equipment of the Snowdon Mountain Railway. Gowrie Colquhoun Aitchison. Descriptive account. 3500 w. Prac Engr—July 6, 1900. No. 35299 A.

Southampton, Eng.

Southampton Corporation Electric Tramways. Brief illustrated description. 2600 w. Elec Rev, Lond—July 20, 1900. No. 35588 A.

Surface Contact.

A New Surface Contact System for Electric Tramways (Ueber ein Neues Unterleitungs-System für Elektrische Strassenbahnen). H. Zacharias. A paper before the Verein für Eisenbahnkunde giving a well illustrated description of the Steudebach system, in which contact is made with the working conductor by means of a simple mechanical arrangement. 5500 w. Glaser's Annalen—June 15, 1900. 35323 D.

Swansea.

The Swansea, Wales, Tramways. Illustrated detailed account. 2800 w. Elec Eng, Lond—July 6, 1900. No. 35407 A.

Three-Phase Ry.

The High-Speed Three-Phase Railway from Toledo to Norwalk, Ohio. Illustrated detailed description. 3500 w. Elec Rev, N. Y.—July 25, 1900. No. 35541.

Ticket Machine.

An Electric Automatic Ticket Machine for Electric Railways (Elektrische Fahrkarten-Automat für Elektrische Bahnen). An illustrated description of a coin-in-the-slot machine for supplying tickets on electric cars, which is operated by electromagnets. 1200 w. Elektrizität—June 9, 1900. No. 35386 C.

Transition Curves.

Transition Curves Used by the Boston Elevated Railway. Gives tables arranged to suit the requirements of this road, with explanatory remarks. 2300 w. St Ry Rev—July 15, 1900. No. 35434 C.

Transportation.

Electric Traction. Rankin Kennedy. Considers the probability of the motor car eventually driving out electric traction. 1100 w. Elec Rev, Lond—July 13, 1900. No. 35479 A.

Travelling Sidewalk.

See Paris, above.

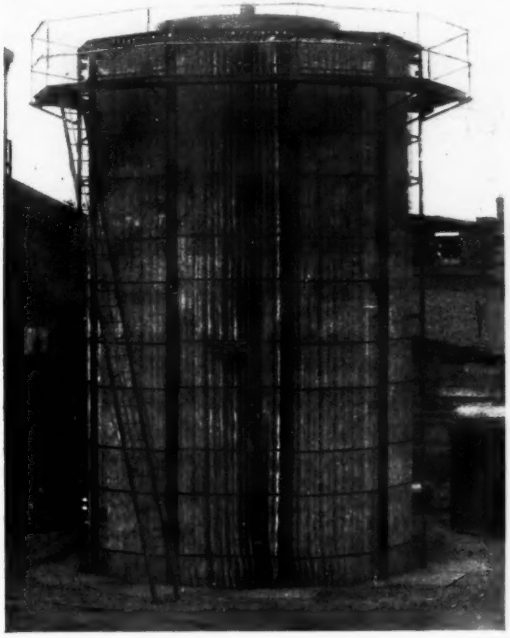
IMPROVED MACHINERY

New Processes and New Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Self-Cooling Water Tower.

For some time past the Wheeler Condenser & Engineering Co., New York, has been building and installing successfully the Barnard-Wheeler cooling tower (fan type), but despite the wide use of this device, they have evolved a cooling tower bringing into play all the desirable features of the original tower, but dispensing with the use of the fans for creating a draught, and consequently, eliminating a constant source of expense, viz., the power necessary to run the fans. The Barnard fanless self-cooling water tower is the result of years of study and costly experiment, the object in view having been to obtain maximum efficiency with minimum cost and space or ground area requirements. All



SELF COOLING WATER TOWER.

mechanical means to circulate the air for cooling the water have been dispensed with. The water distribution system is unique in that provision has been made to operate parts of the tower, where variable loads are encountered, and also what is very essen-

tial, that repairs and cleansing do not entail a shut down. A gallery and ladder provide means of inspection at all times. The entire structure is braced against strains or exposure to wind pressures, insuring rigidity under all conditions. The average height is about 30 feet and the weight per square foot of foundation area is very low, thus allowing for roof installations where ground space is not available. The increased pump duty on a roof tower when used in conjunction with a Wheeler surface condenser is that due to the height of the tower solely, as the uptake and down columns balance below the tower tank.

The accompanying cut shows a 1,000 H.-P. tower. The hot circulating water, when discharged from the condenser, is pumped up through a central stand pipe, from which it is led to a trough and distribution pipes, which ensure the constant flow of a thin film of water over the meshes of galvanized wire mats, which drain into a tank forming the foundation of the tower, and from whence the cooled water is returned for another trip to the condenser. The mats are entirely exposed to the atmosphere and are arranged in such a manner that the circulation of air is complete, and the consequent evaporation carried far enough to reduce the temperature of the water to a sufficiently low point for good condensing purposes, a common reduction being from, say, 135° to between 85° and 90°.

The builders will furnish further information to steam users, setting forth in detail the economies of the system.

A Light-Weight Steam Shovel.

The Vulcan Iron Works Co., Toledo, O., furnish us the illustration and description herewith of the only light weight traction wheel steam shovel made. This shovel weighs 13 tons, complete, has been on the market for about a year, and has met with notable success. It is adapted to any class of work, but more especially to light work, or where a limited amount of yardage is required per day, such as handling clay in brick yards and potteries or in gravel pits.

LIGHT WEIGHT STEAM SHOVEL.

The car body is 16 ft. long, 5 ft. 6 in. wide, made of steel beams and channels, covered with a deck of steel plate. The boiler is 36 in. in diameter, 7 ft. 6 in. high, with a hinged stack and is equipped with a water tank hung under car, of sufficient

capacity to run the shovel for half a day. The hoisting engines, for hoisting the dipper, are 7 x 9¼ ft. and of an improved and substantial type, while the hoisting gear is 36 x 3½ ft. face, especially designed for this shovel. The dipper has a half cubic yard capacity. No jack arms are required. This saves much time in operation of the shovel.

The steam shovel will dig soft or hard materials, from sand to, and including, iron ore, and has a capacity of from 300 to 500 cubic yards per day, according to the class of material handled.

Catalogue, blue prints, etc., will be furnished on application to the builders.

Graphite for Automobiles.

GRAPHITE, which plays an important part in the mechanical arts of the world, is found very useful in reducing friction in automobiles.

A very finely powdered graphite, when introduced into the cylinders of either steam or gas automobiles, very largely assists the oil which is usually employed for the purpose of lubrication.

It seems to be agreed by all engineers that no vegetable or animal oil should be used for the lubrication of engine cylinders. Mineral oil, only, should be used, but even the best mineral oil in the cylinders of gas engines chars under very high heat, due to the combustion of gases. The heat in a gas engine cylinder is said to be from 1,200 to 2,000 degrees F., and graphite only is able to bear this extreme heat.

Special graphite lubricants are prepared for the gears of both electric, steam and gas motors. For the driving chains on steam or gas automobiles, graphite in some form should always be used, as it saves power and at the same time so thoroughly lubricates the links that it will prevent the chains from breaking.

When used for the chain, the graphite should not be used with any grease, as the sticky grease causes the dust and dirt to adhere to the chain, thereby practically shortening the chain and making it unnecessarily tight. The graphite should be used with a nice quality of vaseline or should be mixed with gasoline or turpentine, and applied to the chain. The gasoline or turpentine will evaporate, leaving a thin coating of graphite on the chain.

The Joseph Dixon Crucible Co., Jersey City, N. J., who are authorities on the subject of graphite, will furnish further information to those who may be interested.

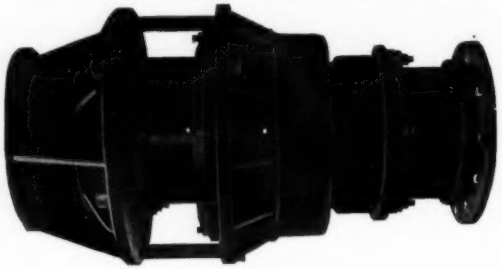
Recent Export Orders.

ONE of the most striking features, in the progress made by American manufacturers in the markets of the world, is the success attending the efforts made by manufacturers of technical and scientific instruments. In former years the Germans practically controlled the trade of the world on these lines, but American manufacturers to-day are making such rapid progress that they seriously threaten in many branches to replace German and English makers. The most encouraging feature is that in nearly every instance it is upon the superior quality of the American product. This came specially to our attention through the recent successes of the Hohmann & Maurer Manufacturing Co., Rochester, N. Y., makers of instruments for all mechanical, engineering and scientific purposes; in competition with both German and English makers they have recently secured large orders from Russia for the equipment of beet-sugar factories, and from Japan for the equipment of two rubber works. Within the last month they have made shipments to South Africa for the equipment of a large brewery, to the Argentine Republic for cold storage purposes, and to Australia for cold storage and meat packing. In nearly every instance the orders have come to them solely on the reputation which their goods have acquired, and without any direct effort being made to acquire the business. Formerly the theory on export business was that in order to acquire a hold in the markets of the world American manufacturers must be able to produce something at a less cost than was being supplied by other makers. It is a gratifying sign to note that the present tendency is more directly in the line of seeking the foreign trade upon the quality of the product rather than upon its price.

Balanced Expansion Steam Joint.

THE cut herewith represents a balanced expansion steam joint, designed for any size steam pipes requiring the same. There

are many places (where large power plants are installed) where it is quite necessary to use something of this kind. As the pressure varies, the contraction and expansion take place, and unless the device is sensitively balanced there is great strain on the flanges, fittings, etc. Owing to the construction of this joint, consisting of steel castings and brass, it will stand the pressure



BALANCED EXPANSION STEAM JOINT.

without being so bulky as to be unsightly. Very little stress is brought upon the joint to make it operate, it being so accurately balanced it has only the friction of the packing in the stuffing boxes. This joint was designed by Mr. Sommers N. Smith, of long experience in the ship building business, who had often felt the need of a device of this kind for use on large steamers, and none could be purchased to fill the necessary requirements. This joint is the result of his labors, making a device that absolutely does all that is required under similar conditions, or any place using steam pipe. They are made to fit any size steam pipe.

Prices and particulars cheerfully given by the manufacturers, H. B. Underwood & Co., Philadelphia.

The Taylor-White Process Tool Steel.

In the reorganization of the shop methods of the Bethlehem Steel Co., South Bethlehem, Pa., F. W. Taylor found that a necessary change was the discontinuance of the miscellaneous assortment of tool steels used by the different men in the shop, and the adoption of a standard and uniform grade. A special lathe was set aside for the purpose of experimenting with tool steels of different makes, with a view to selecting a standard for use, and several men were set to work testing the relative merits, not only of the different tool steels then in the shop, but of all brands of established reputation. This full and exhaustive investigation led to the discovery which has resulted in the remarkable development now seen in their machine shop. In the tests of these various makes of tool steels over 200 tons of steel forgings were cut up into turnings on the experimental lathe. The outcome of this work has been the discovery of the process known as the "Taylor-White," which has been purchased by the Bethlehem Steel Co.

This process consists in the treatment of the tool after it has been forged, and imparts to the steel the valuable and exceptional property of retaining a high degree of hardness when heated to a visible red. It is possible with one of these tools to cut steel at a speed so great as to heat up the point of the tool to redness, and have it continue to cut several minutes at this speed, leaving an unusually smooth finish on the work, as well as cutting accurately to size. The practical speeds at which these tools will run have been found to be from two to four times that of any steels with which the company have experimented.

The process is in no sense one of surface hardening. After the tool has been machined to shape and the process applied, the penetration is to the center of the steel, even in tools as large as 4 inches in diameter. In other words, the center of the tool is in precisely the same condition as those portions near the surface. While all of the standard brands of self hardening steel which have been experimented with are improved to a greater or less extent by the

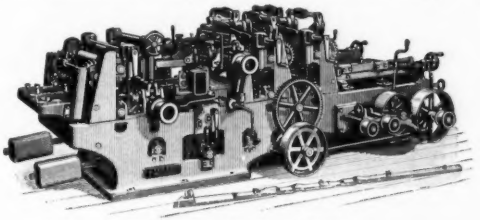
treatment, it is preferred to use a steel of special composition, in order to get the greatest uniformity and maximum results. This special steel forges so much more readily than the general run of self hardening steels that tools of difficult shapes may be easily formed. The thorough penetration effected by the process insures the use of the tool until it becomes so small, by reason of regrinding, that it cannot be held in the machine. This special steel can be annealed so that it can be easily machined to shape, making it applicable to twist drills, chasers, inserted cutters, etc. The tools made in accordance with this method are also extremely uniform in quality, so that the work on which they are used can be regularly performed at the maximum rate of speed.

After these tools were introduced in the machine shops of the Bethlehem Company it was found necessary to overhaul the entire plant, both as regards machines and line shafting. While the results have been unprecedented the end has not yet been reached, mainly because of lack of power in the driving mechanism of the different machines. In many cases it is impossible to operate the machines at the speed desired and at the same time take the heavy cut of which the tool is capable. The main lines of shafting have been speeded from 90 to 250 revolutions, and further changes in countershafts have been made to speed up individual machines, this combination being largely responsible for the increased efficiency of the shop. The table below shows the increase in efficiency of each tool per hour in terms of metal removed:

Average	October 15 1898	May 11, 1899	January 15, 1900	Gain in per ct. cut of third over second	Gain in per ct. cut of third over first
Cutting speed.....	8 ft. 11 in.	21 ft. 9 in.	25 ft. 3 in.	16	183
Depth of cut.....	0.23 in.	0.278 in.	0.30 in.	8	30
Feed.....	0.07 in.	0.0657 in.	0.087 in.	32	24
Pounds of metal removed per h....	31.18	81.52	137.3	68	340

A great advantage in the use of these tools is that when cutting dry at the rate of maximum efficiency the chips should come off blue. These blue chips enable the foreman, at a glance, to tell whether the work is being done at the proper speed. When running under water at the correct cutting speed the chips should show blue immediately upon shutting off the water and allowing the tool to cut dry for a little while.

The company are introducing this method of treating steel by granting shop rights. The purchaser is supplied with all information necessary to carry on the work.



SIX ROLL PLANING MACHINE.

Six Roll Planing Machine.

We illustrate a machine just brought out and placed on the market by J. A. Fay & Co., Cincinnati, O. It is their new No. 25 heavy six-roll double cylinder planing, matching and jointing machine, and is the largest and heaviest combined planer and matcher made. This machine will plane 30 inches wide and 14 inches thick, and will work simultaneously three sides of two pieces of material, of uneven thickness, up

to 12 inches wide and 14 inches thick. The frame is massive, perfectly jointed, and bolted to secure rigidity. The cylinders are made from solid-forged steel, and are slotted on all their faces. The matching works are very substantial, and are fitted with a patent weighted matcher-clip for working cross-grained and knotty lumber, and producing rapid and accurate work. The feed works are very powerful, consisting of six rolls eight inches in diameter, connected by a train of heavy expansion gearing, with double links, and are heavily weighted.

The manufacturers will furnish prices and full particulars upon request.

Industrial Notes.

The Manhattan Railway Company, New York, in the building of its mammoth steam-electric power stations, has awarded to the Harrisburg Foundry & Machine Works the contract for the engines to operate the exciter dynamo in their new Seventy-seventh street power house. Ordinarily an order for engines simply to operate exciters would be a small affair, but in this case, on account of the huge proportions of the plant, it amounts in the aggregate to 1,600 H.-P.—quite a power plant in itself. This was an order that attracted unusual attention among both users and builders of engines, for the new station where the engines are to be installed is designed to be second to none in the completeness of its equipment, and no pains were spared in the selection of the very best machinery of all types for the various services required. The exciter engines, as they are called, are four in number, each of 400 indicated H.-P. capacity, each direct-connected to a 250 k.-w. direct-current dynamo of the Westinghouse Electric & Mfg. Co.'s make. These dynamos are of the 8-pole type, wound for a thousand ampères at 250 volts and guaranteed 93 per cent. efficiency. The Harrisburg engines are of the tandem compound type, the cylinders being 14 inches and 25 inches in diameter by 18 inches stroke. They are to operate at a speed of 200 revolutions per minute with 150 pounds' steam pressure.

The Aultman Company, Canton, Ohio, advise us that recent orders include a sand handling system for the foundry of the Massillon Iron & Steel Company, at Massillon, Ohio; two large No. 5 Aultman rock crushers for the Bonnot Company, of Canton, Ohio; one No. 3 Aultman rock crusher and one car haul for the Page Woven Wire Fence Co., of Monessen, Pa.; one refuse conveyor for the Acker Lumber Co., of Livermore, Ky.; one refuse carrier for the Hall & Lyon Furniture Co., of Waverly, N. Y.; one complete plant for the manufacture of tile and building block for the Beatty Fire Clay Co., of Magnolia, Ohio; one tipple house equipment for the Indian Run Coal Co., of Canton, Ohio; one complete system of elevating and conveying machinery for handling raw material and finished product at the beet sugar refinery of A. W. Colwell & Co., Marine City, Mich.; six ingot charging machines for the Wellman Seaver Engineering Co., Cleveland, and a pulp carrier for the Munroe Falls Paper Co., Munroe Falls, Ohio.

H. W. Johns Mfg. Company's new Navy Brand asbestos fire felt covering has been adopted for the pipe work in the Albany capitol building of this State. The covering first put on by another company is to be removed and replaced by this new style material. The contract amounts to $4,000. They were also successful in securing the pipe and boiler covering work for the new addition of the Manhattan Hotel, New York City.

The Chicago Pneumatic Tool Company has engaged Fred F. Bennett as sales agent and manager of advertising, with headquarters at the main office of the Company, Monadnock Block, Chicago. Mr. Bennett was formerly sales agent for the American Steel Casting Company and American Coupler Company, Chester, Pa.

The North American Metaline Co., Long Island City, New York, sole manufacturers of the metalined or oiless bearings for machinery, have just increased their power by installing a new Worthington water-tube boiler of 109 H. P. capacity.

The Egan Co., Cincinnati, O., have just issued a large illustrated hanger, showing nearly 100 of the different machines they make, among which will be found some of the very latest improvements in this line. A number of the machines have been pat-

ented since January 1, 1900, and an examination into their merits and capabilities will prove very interesting. The Egan Co. will forward one of these hangers and further information on request.

The New York Filter Manufacturing Co., New York, reports that it has received a contract for the complete equipment of the Watervliet Arsenal with filters of 400,000 gallons capacity; also a contract for a 12,000,000-gallon filtration plant for the Tintern Manor Water Co., Redbank, N. J.

The Link Belt Engineering Co., Nicetown, Philadelphia, manufacturers of the well known link-belt elevators and conveying machinery, report an unusually active condition of business, with no present outlook of slack orders. Twice they have been compelled to increase their capacity during the past few months, and are at present building a large extension to their workrooms, and also the draughting department. New machinery of the most modern types has been installed to facilitate the more rapid filling of orders, and a number of additional workmen employed.

L. G. Barger, for many years with the transportation department of the West Shore Railroad and recently connected with the New York Air Compressor Co., has accepted the position of chief clerk to Superintendent Ketcham, on the Morris & Essex division of the Delaware, Lackawanna & Western Railroad.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Industrial Water Company, New York.—A neat catalogue describing water softening and purifying apparatus for softening water before it enters the feed-water heater on the boiler.

The General Power Co., New York.—A pamphlet describing the Secor system (kerosene engine) of generating power for all purposes.

Fort Wayne Electric Works, Ft. Wayne, Ind.—Brochure showing the dynamos, lamps, switchboards, etc., manufactured by this company. No text accompanies the engravings.

California Portland Cement Co., Los Angeles, Cal.—Well printed catalogue of structures on which this company's product has been used. Many useful suggestions on the proper use of Portland Cement are to be found here.

Franc C. McLain, New York.—Illustrated catalogue of steam and hot water boilers, radiators, tanks, valves, supplies, etc.

Bickford Drill & Tool Co., Cincinnati, Ohio.—Handsomely printed and illustrated catalogue of radial, half universal radial, and full universal radial drills, port drills, wall radial drills, suspension drills, traveling drills, and special drills of many kinds.

Union Switch & Signal Co., Swissvale, Pa.—Large and well illustrated catalogue describing the electro-pneumatic interlocking system installed at the Boston Southern station. Many interesting views are given, together with track plans and diagrams of signaling.

Follansbee Brothers Co., Pittsburgh, Pa.—Brochure giving views of public and private buildings roofed with "Scott's Extra Coated" roofing tin.

Commercial Electric Co., Indianapolis, Ind.—Circular No. 120, describing direct connected engine type dynamos.

New York Central & Hudson River Railroad, New York.—Two new folders, Nos. 100 and 101, which are notable for the variety of information they give the traveler about the Central and connecting lines and the handsome maps they show.

Gisholt Machine Co., Madison, Wis.—Catalogue J, being a very handsome book illustrating and describing many types of lathes and universal tool grinders.

Lehigh Valley Railroad, New York.—The Signal System of the Lehigh Valley Railroad, being a 10-page pamphlet describing in detail the block-signal system in use along the lines of this road.

C. W. Hunt Co., New York.—Pamphlet No. 008, illustrating and briefly describing industrial railway cars, electric locomotives, steam and electric hoisting engines, elevators, etc., manufactured by the C. W. Hunt Co.

Bethlehem Steel Co., South Bethlehem, Pa.—Handsomely illustrated and descriptive catalogue of forgings for marine and stationary engines, machine tools, armour plate, gun forgings, carriages and mounts, and ordnance material of all kinds.

NEW CATALOGUES.

Wyman & Gordon, Worcester, Mass.—A neat folder illustrating a group of forgings for railroad car equipment, ordnance work, balls for bearings, pneumatic machinery, cream separators, textile machinery, electric railroad construction, etc.

Joseph Dixon Crucible Co., Jersey City, N. J.—Pamphlet describing many varieties of graphite facing for the moulder.

Ransome & Smith Co., Brooklyn, N. Y.—Well printed and interesting catalogues describing Ransome's concrete mixers.

Vulcan Iron Works Co., Toledo, Ohio.—Very handsome brochure illustrating and briefly describing the "Baby Giant" steam shovel on railroad trucks.

F. A. La Roche & Co., Chicago, Ill.—A convenient catalogue of circuit breakers and automatic switches.

Iroquois Iron Works, Buffalo, N. Y.—Illustrated catalogue and general description of steam road rollers.

Skinner Chuck Co., New Britain, Conn.—Leaflet describing the Skinner "Independent" lathe chuck.

Sherwood Manufacturing Co., Buffalo, N. Y.—Illustrated 32-page catalogue of double-tube, automatic, and drive well injectors, with cable code to facilitate ordering.

Weber Gas and Gasoline Engine Co., Kansas City, Mo.—Very complete catalogue of gas and gasoline engines, hoisting engines, and irrigation and deep pumping machinery.

Northern Engineering Works, Detroit, Mich.—Neat catalogue of the "Peerless" gas and gasoline engines.

International Correspondence Schools, Scranton, Pa.—Pamphlet in colors recounting the origin and growth of these schools and their method of instruction.

American Blower Co., Detroit, Mich.—Well printed catalogue of "A. B. C." exhaust fans for the removal and conveying of shavings and dust, elevating and distributing cotton and wool, removal of smoke and fumes, and for use in connection with special heating and drying plants.

Ferracute Machine Co., Bridgeton, N. J.—Profusely illustrated catalogue of foot and power presses, lathes, beaders, dies, etc., for working bar and sheet metals, paper, cloth, and leather.

Detroit Graphite Mfg. Co., Detroit, Mich.—Illustrated brochure telling about the graphite paint manufactured by this company.

Chicago Pneumatic Tool Co., Chicago, Ill.—Attractive and very interesting catalogue describing many kinds of pneumatic tools and illustrating them and their uses.

Cahall Sales Department, Pittsburgh, Pa.—Fifth edition of a catalogue of the "Cahall" water-tube boilers.

Frazer & Chalmers, Chicago, Ill.—Complete catalogue of hoisting and haulage engines and appliances.

Baldwin Locomotive Works, Philadelphia, Pa.—"Record of Recent Construction, No. 19," being a handsome pamphlet describing, with accompanying illustrations, the notable locomotives manufactured by this firm.

Great Northern Portland Cement Co., Detroit, Mich.—Very handsome catalogue in colors, giving views of their mills and buildings in which this company's cement is used.

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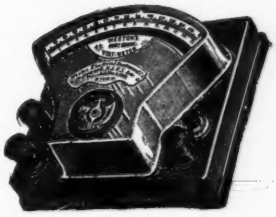

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LONDON: Elliott Bros., 101, St. Martin's Lane.

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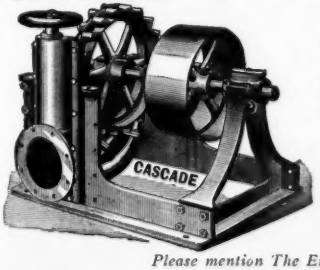

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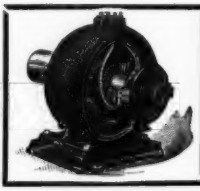

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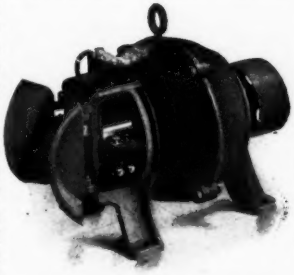

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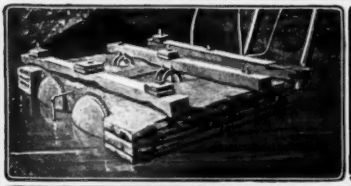

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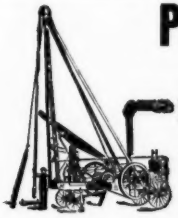

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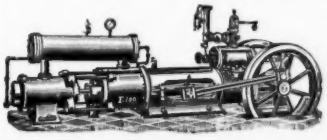

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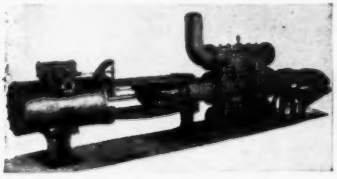

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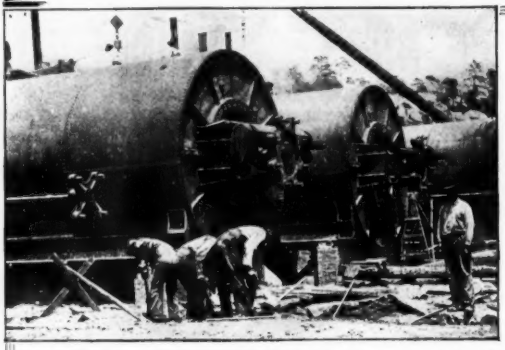

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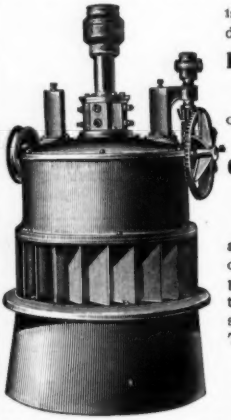

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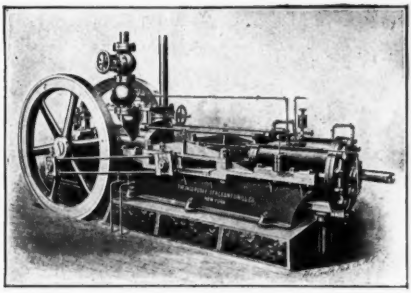

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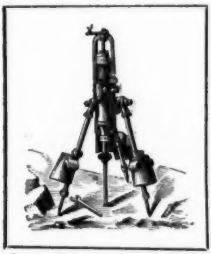

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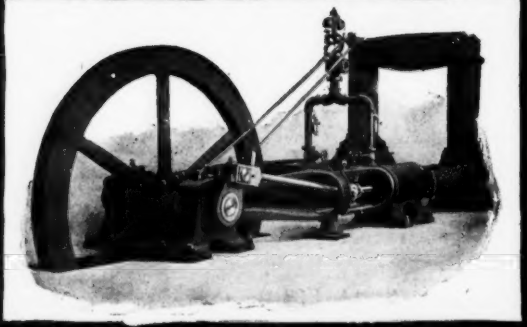

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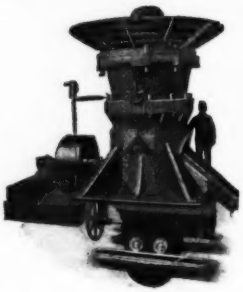

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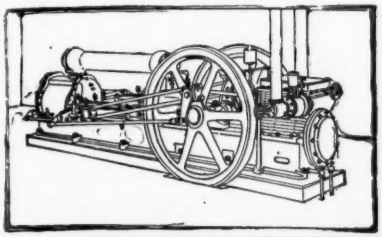

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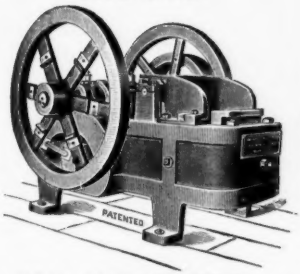

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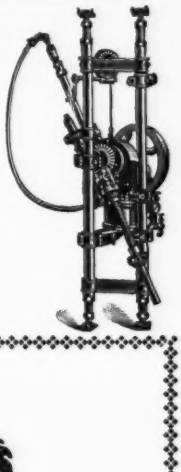

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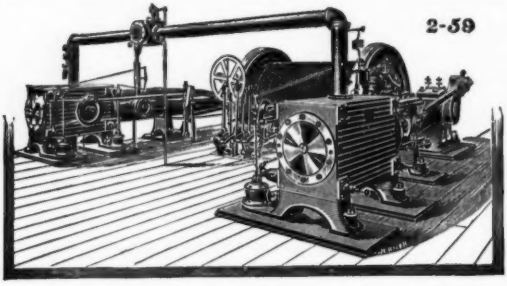

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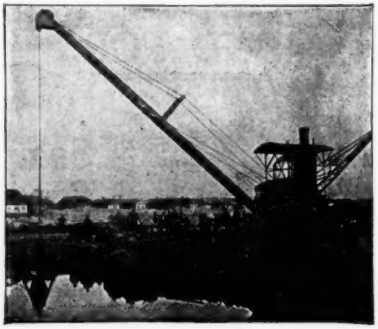

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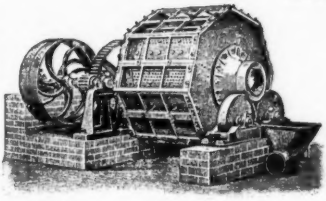

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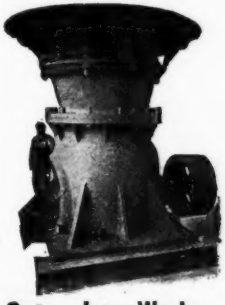

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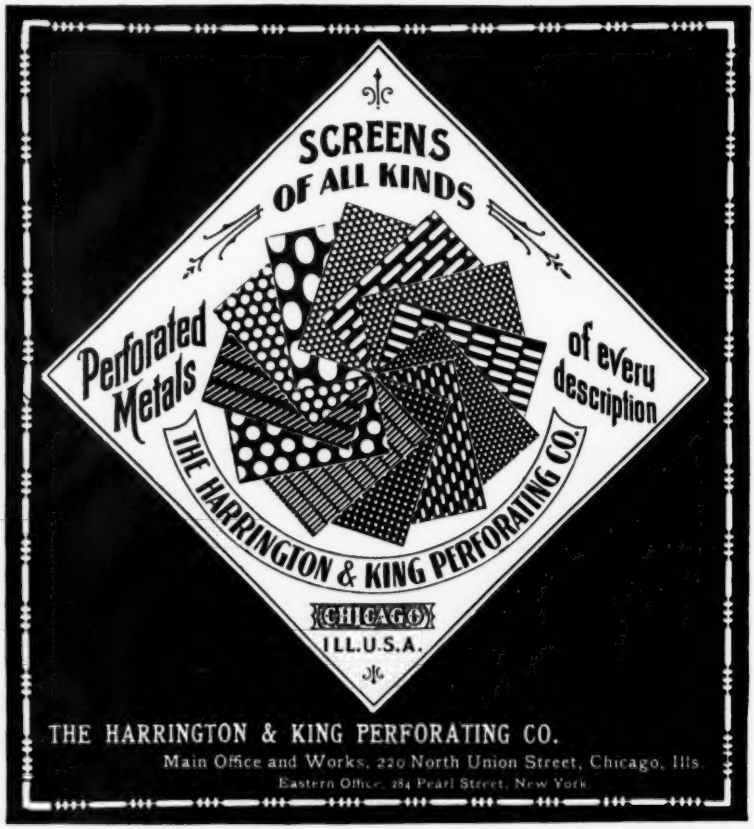
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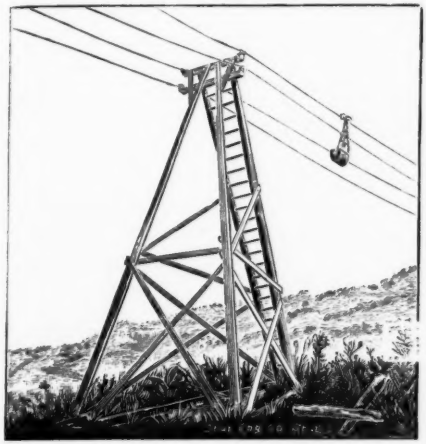

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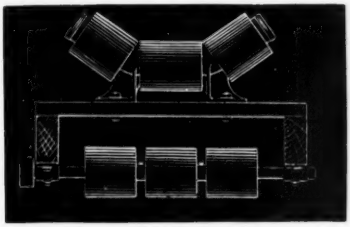

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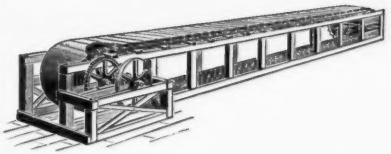

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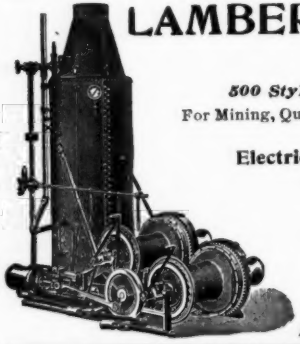

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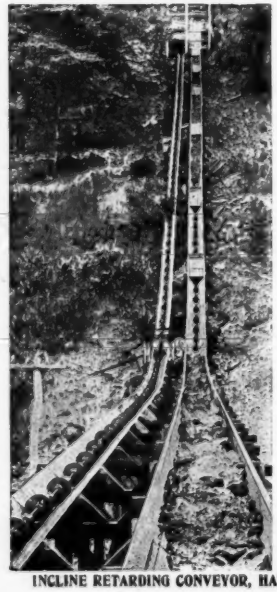

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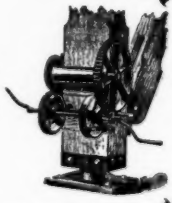

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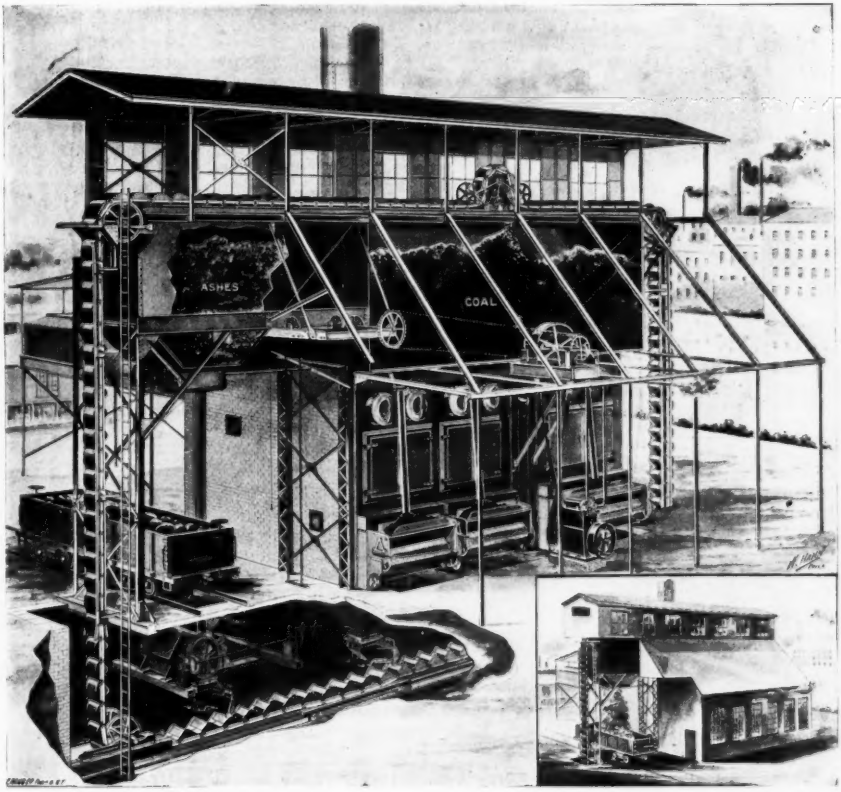

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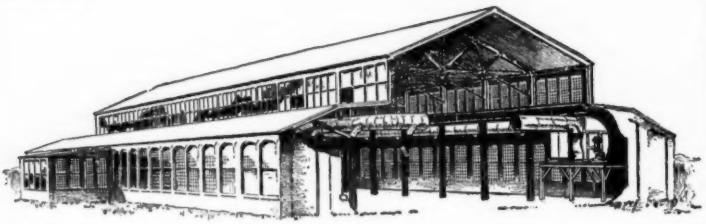

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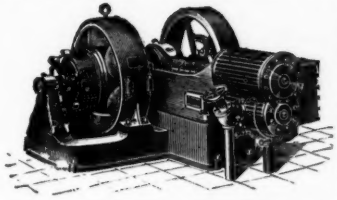

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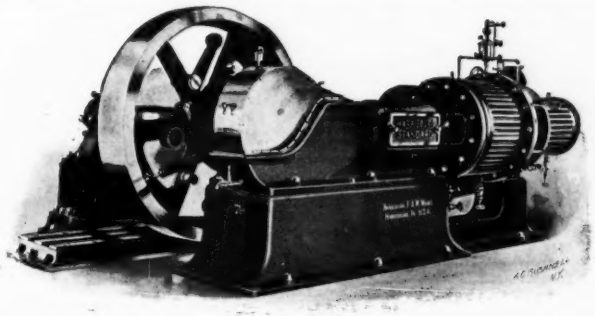

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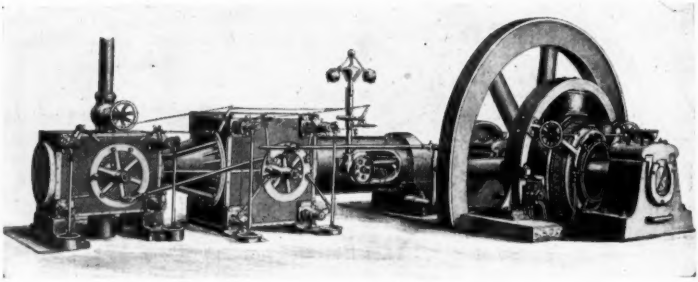

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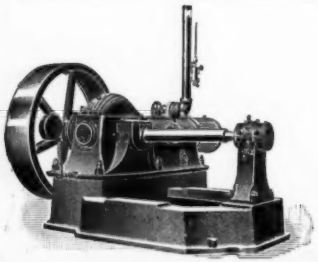

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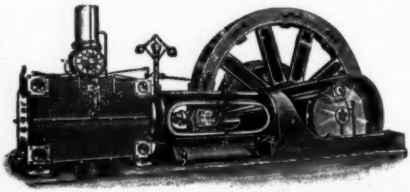

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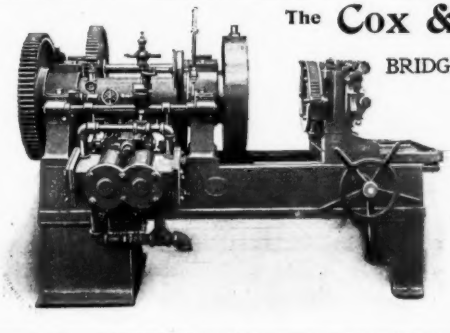

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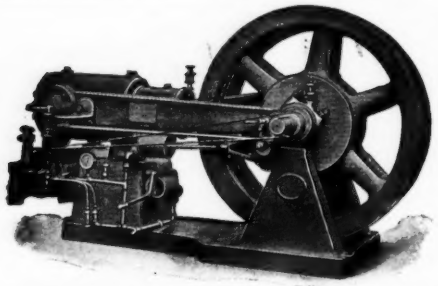

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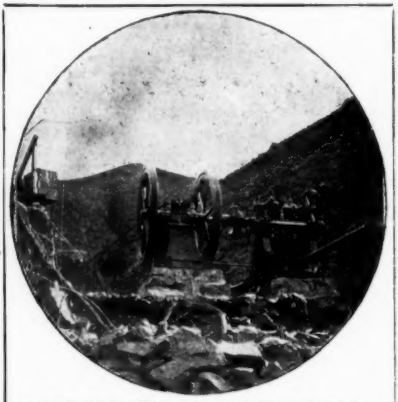

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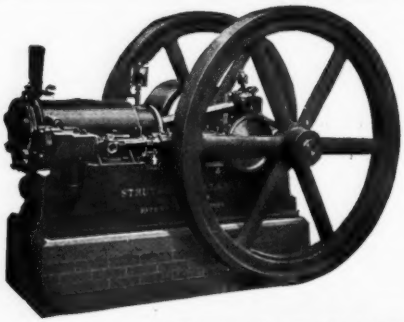

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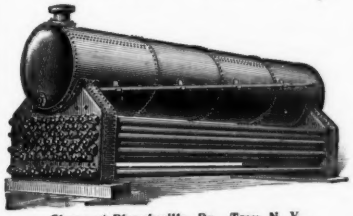

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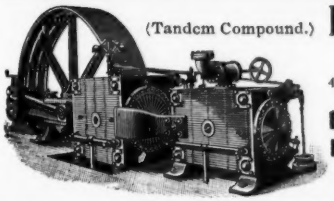

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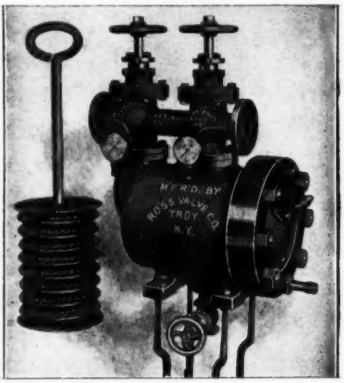

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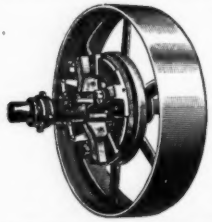

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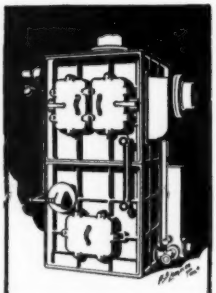

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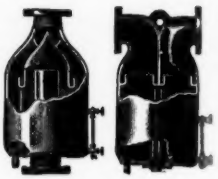

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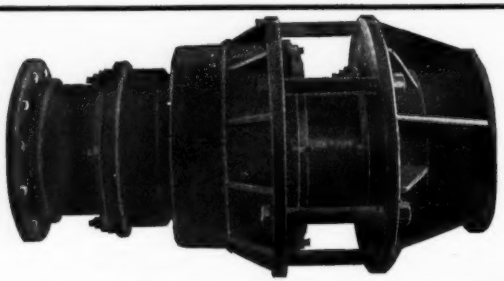

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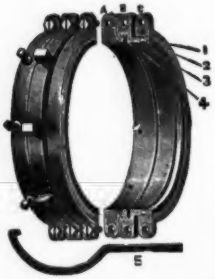

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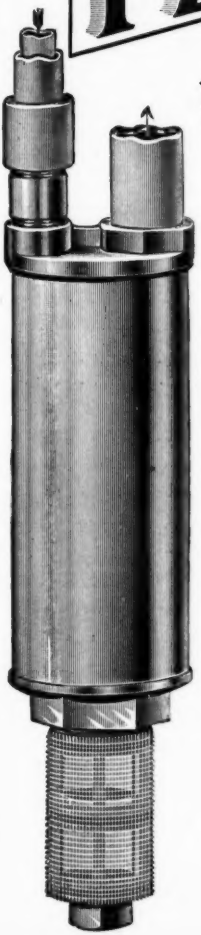

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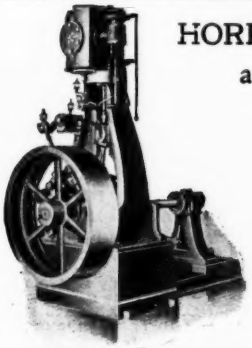

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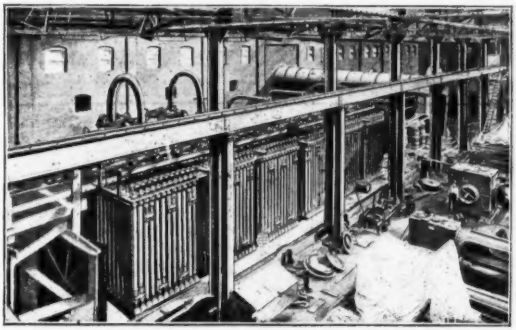

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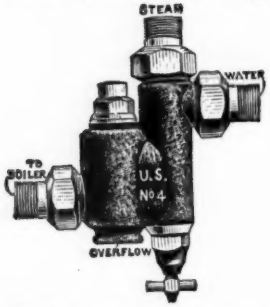

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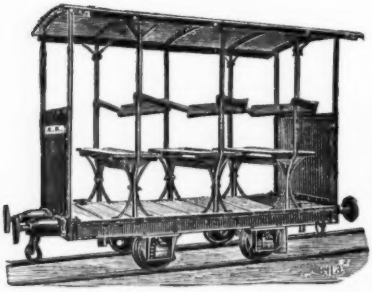

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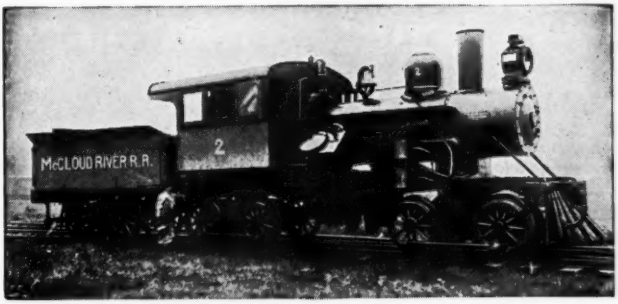

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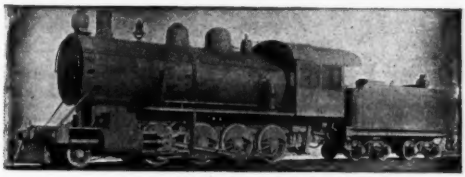

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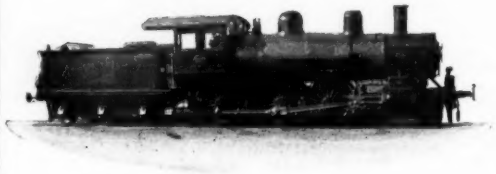

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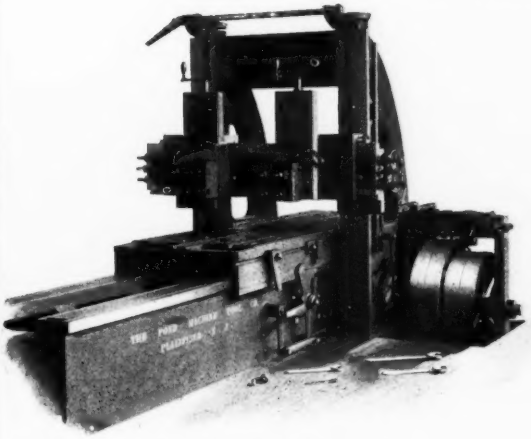

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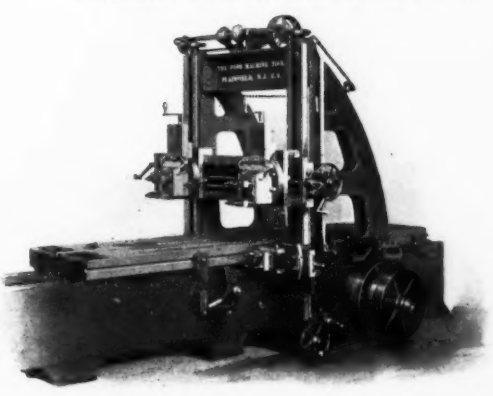

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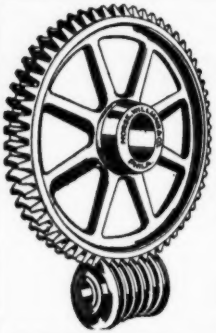

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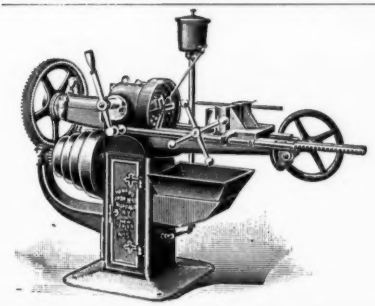

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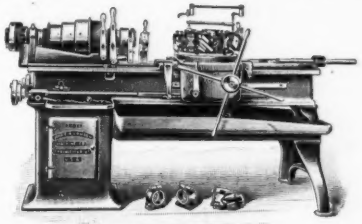

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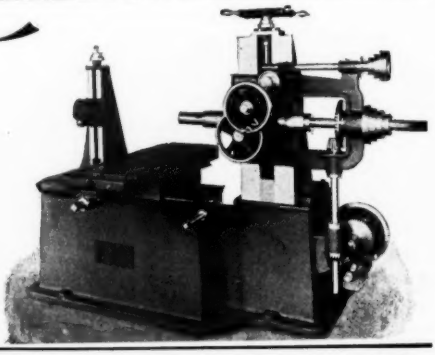

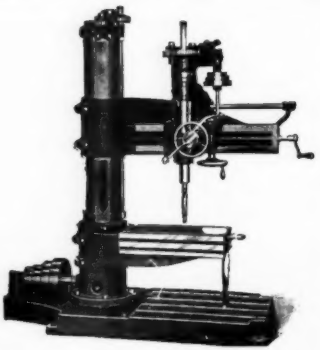

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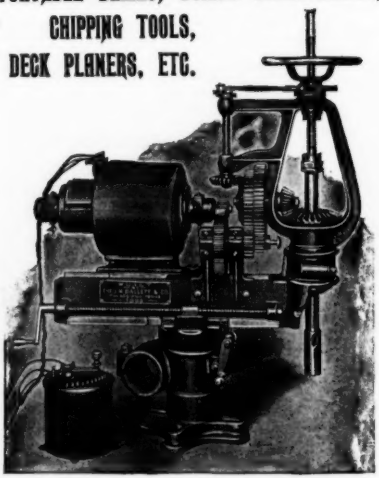

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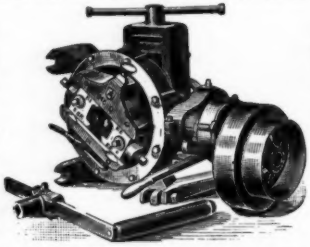

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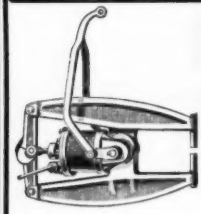

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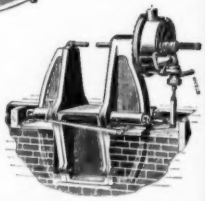

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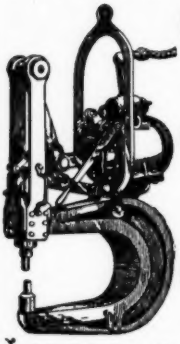

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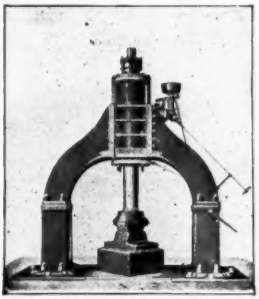

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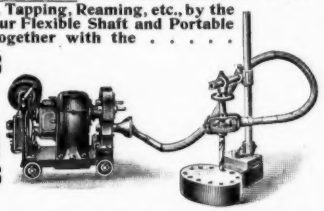

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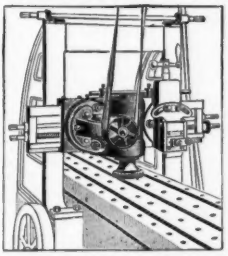

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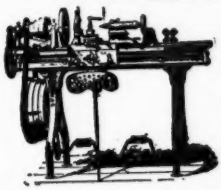

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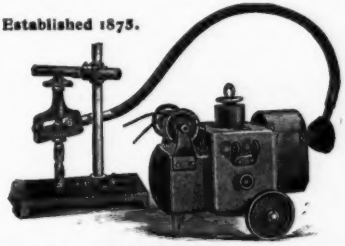

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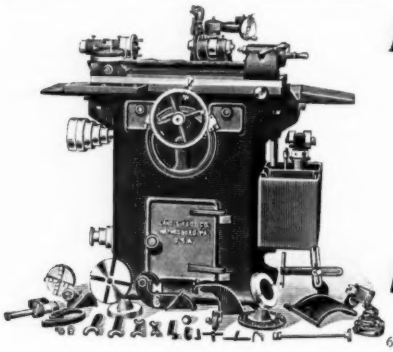

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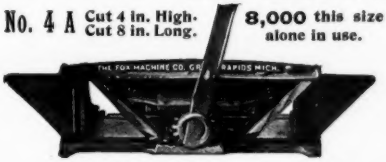

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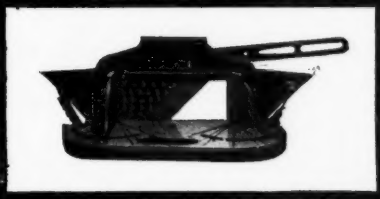

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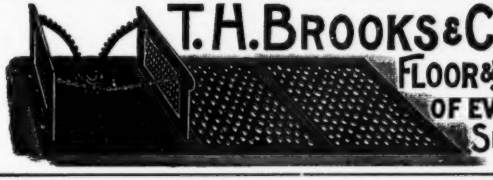

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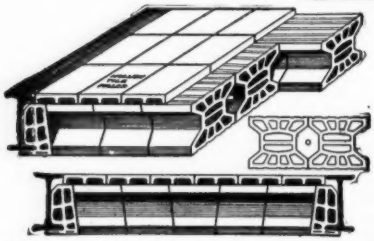

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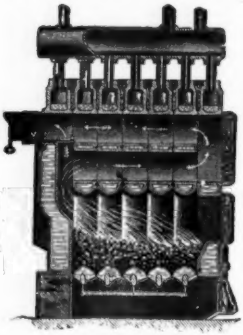

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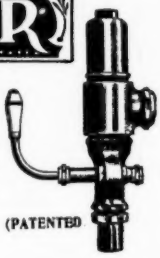

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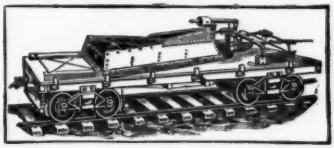

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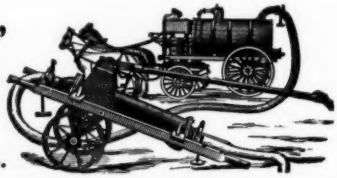

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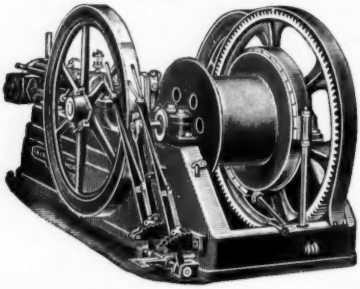

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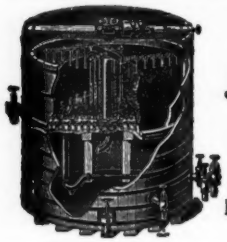

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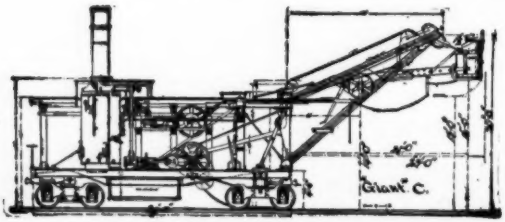

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HON. JOHN BARRETT *(The Crisis in China. Its Meaning to the Engineering World)*—Late United States Minister to Siam, and regarded as one of the best American authorities on far eastern questions. He is a descendant of an old Massachusetts family, more recently resident in Vermont; a graduate of Vermont and Worcester Academies, and B. A. of Dartmouth College (1889) where he made a special study of economics and politics. For some years pursued the study of international law and relations, traveling through the Southern States, South America, Europe, Asia and Hawaii, and publishing the result of his observations in various periodicals. He was appointed Minister to Siam by President Cleveland in 1894, and there scored an important diplomatic success in the settlement of the Cheek case, in which Sir Nicholas Hannen was arbitrator. Leaving his post in May, 1898, Mr. Barrett went to Manila, renewing observations made some years before. Since that time he has traveled in China and Japan, studying political and commercial conditions. He has lately addressed, by invitation, the Chambers of Commerce of Shanghai, Hong Kong, and the State of New York, and the Colonial party of the House of Commons, upon political and trade relations in the far east, and especially the interest and policy of the United States, and has written essays upon the same topic for the leading literary magazines and reviews of England and the United States.

THOMAS TONGE *(The Fourth Era of the Leadville Mining District)*—Born at Styal, near Manchester, England, in which city he was connected with the legal profession from 1864 to 1883; in that year, by the advice of his physician, he moved to Denver, Colo., where he became an American citizen; since 1883 he has made a special study of questions affecting the mining interests, especially of Colorado, and the statistics of the gold and silver districts of the western United States, on which he has for years past been regarded as one of the leading, best-informed, and most reliable authorities; during his residence in Denver he has been a frequent contributor to the mining press of England and the United States.

FREDERICK MACFIE MAYNARD *(Heavy Motor Vehicles for Road Service)*—Born 1863, near London. Educated partly at private colleges in England and partly at the Anstalt der Brudergemeine Neuwied on the Rhine, Germany. Author of "Motor Traction" and many other technical papers.

ELMER F. CASSEL *(Commercial Requirements of Water-Power Governing)*—Born at Galesburg, Ill.; educated at Knox College in the same city; 1885-1890 was manager and superintendent of the Seattle, Lake Shore, and Eastern Railway; 1892-1897 auditor and acting manager of the American, Howell, and Berners Bay Associated Mining Companies; 1897-1899 manager and engineer of the Alaska-Pacific Mining Co.; for the past three years Mr. Cassel has been engaged in the special study of the use of high-head water power in connection with the mining industries of Alaska.

SYDNEY F. WALKER *(Electric Mining Machinery in the British Colleries)*—Born 1852; educated at Christ's Hospital, from which he passed into H. M. S. "Britannia," training ship for naval cadets; served in the Navy at various stations, eventually being allowed to retire on favourable terms; studied for a time in telegraph schools, and then obtained an appointment on the staff of Sir W. Thomson; later had sole charge of the core-testing at Mitcham; later was electrician in the Gramme Magneto-Electric Co. Mr. Walker has pioneered many improvements in electrical work applied to mining, and has a large mining connection in the Cardiff district. Member of the Institution of Electrical Engineers, of the Institution of Mechanical Engineers, of the Federated Mining Institute, of the South Wales Institute of Engineers, Associate Member of the Institution of Civil Engineers, Member of the Institute of Marine Engineers, and of the American Institute of Electrical

Engineers. One of the original Fellows of the Imperial Society. Frequent contributor to technical literature; author of "How to Light a Colliery by Electricity," of "Electric Lighting for Marine Engineers," and of "Electric Light and Power in Mines."

WILLIAM RIPPER *(The Continuous Recording of Steam-Engine Performance)*—Born 1853 at Plymouth; apprenticed at the Plymouth Foundry and Engine Works Co. and afterwards worked at the Marine Engine Works of Messrs. Blair at Stockton-on-Tees; in 1884 was appointed assistant professor of mechanical engineering at the University College, Sheffield; and in 1899 was made head of the technical department and professor of engineering at the same college; visited the United States, Canada, France, and Germany and reported upon the educational systems of those countries; he has devoted much attention to the subject of superheating and read a paper on this subject before the Institution of Civil Engineers; Professor Ripper is the author of various well-known books for engineering students, including "Steam-Engine Theory and Practice," "Steam," "Machine Drawing and Design," and "Practical Chemistry," and is the inventor of the mean-pressure indicator.

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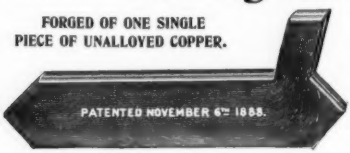

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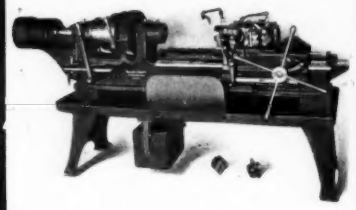

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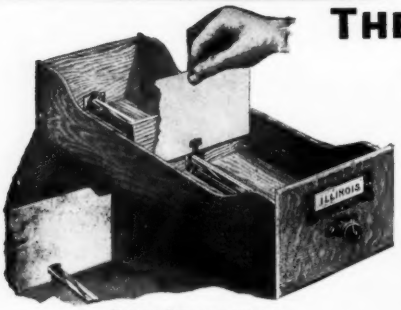

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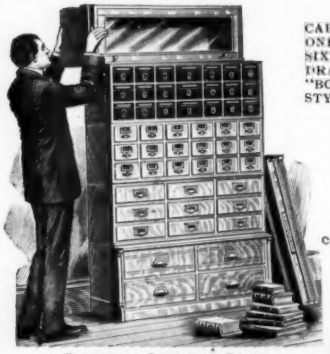

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A Buyers' Directory of

THE ENGINEERING TRADES.

NOTE.—*The display advertisements of the firms mentioned under each heading can be und oreadily by reference to the Alphabetical Index on page 23.*

Acid Works Castings.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Advertising Exerts.
Manufacturers' Advertising Bureau, 126 Liberty St., New York.

Air Brakes.
Westinghouse Air Brake Co., Pittsburg, Pa.

Air Brake Pump Governors.
Mason Regulator Co., Boston, Mass.

Air and Gas Compressors.
Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
M. C. Bullock Mfg. Co., 1173 West Lake St., Chicago, Ill.
Clayton Air-Compressor Wks., 26 Cortlandt St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Holly Manufacturing Co., 120 Liberty St., New York.
Ingersoll Sergeant Drill Co., 26 Cortlandt St., New York.
Knowles Steam Pump Works, 91 Liberty St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, N. Y.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Sullivan Machinery Co., Chicago, Ill.
Weber Gas & Gasoline Engine Co., 428 Southwest Boulevard, Kansas City, Mo.
Henry R.Worthington, 120 Liberty St., New York.

Air Hoists.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Knowles Steam Pump Works, 91 Liberty St., New York.
Whiting Foundry Equipment Co., Harvey, Ill.

Air Motors.
Philadelphia Pneumatic Tool Co., Philadelphia,Pa.

Anti-Friction Metals.
Merchant & Co., Inc., Philadelphia, Pa.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Arc Lamps—see Lamps, Electric.

Alums, Filter.
Harrison Bros. & Co., Inc., Philadelphia, Pa.

Ash Hoists.
Bethlehem Foundry & Machine Co., South Bethlehem, Pa.

Axles.
Bethlehem Steel Co., South Bethlehem, Pa.

Babbitt Metals.
Merchant & Co., Inc., Philadelphia, Pa.
Paul S. Reeves & Son, Philadelphia, Pa.

Balanced Steam Joint.
H. B. Underwood & Co., Philadelphia, Pa.

Balanced Valves.
Mason Regulator Co., Boston, Mass.

Ballast Unloader Cables.
American Steel & Wire Company, Chicago, Ill.

Ballast Unloaders.
Marion Steam Shovel Co., Marion, Ohio.

Balls, Steel.
Cleveland Ball & Screw Co., Cleveland, Ohio.

Bank-Vault Plates.
Bethlehem Steel Co., South Bethlehem, Pa.

Belting Conveyers.
Aultman Company, Canton, Ohio.
Jeffrey Manufacturing Co., Columbus, Ohio.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
Link Belt Engineering Co., Nicetown, Philadelphia, Pa.
Robins Conveying Belt Co., Park Row Building, New York.

Belt Dressing.
Jos. Dixon Crucible Co., Jersey City, N. J.

Belting.
Aultman Company, Canton, Ohio.
Buhl Malleable Co., Detroit, Mich.
Fairbanks, Morse & Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Engineering Co., Philadelphia, Pa.
Main Belting Co., Philadelphia, Pa.
Robins Conveying Belt Co., Park Row Building, New York.
Chas. A. Schieren & Co., 45-51 Ferry St., New York.

Belt Lacing.
Bristol Co., Waterbury, Conn.

Bending Rolls.
Bethlehem Foundry & Machine Co., South Bethlehem, Pa.
Bethlehem Steel Co., South Bethlehem, Pa.
Hilles & Jones Co., Wilmington, Del.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Bicycle Manufacturers' Machinery.
Fox Machine Co., Grand Rapids, Mich.
Stow Flexible Shaft Co., Philadelphia, Pa.

Blacksmiths' Tools.
Buffalo Forge Co., Buffalo, N. Y.
Hammacher, Schlemmer & Co., 209 Bowery, N.Y.

Blast Furnaces.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.

Blowers.
American Blower Co., Detroit, Mich.
American Gas Furnace Co., 23 John St., New York.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., 1173 West Lake St., Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Sprague Electric Co., 527 W. Thirty-fourth St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Boilers.
American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass.
Aultman Company, Canton, Ohio.
Edw. P. Allis Co., Milwaukee, Wis.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Heine Safety Boiler Co., St. Louis, Mo.
New York Safety Steam Power Co., 107 Liberty St., N. Y.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
S. Morgan Smith Co., York, Pa.
Star Drilling Machine Co., Akron, Ohio.
Stearns Manufacturing Co., Erie, Pa.

For Alphabetical Index to Advertisers, see page 22.

The Stirling Co., Chicago, Ill.
Thorpe, Platt & Co., New York.
Robt. Wetherill & Co, Chester, Pa.

Boiler Fronts and Fittings.
Vulcan Iron Works, Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Boiler Compounds.
Chicago Boiler Cleaner Co., 827 Monadnock Block, Chicago, Ill.
Dearborn Drug & Chemical Works, 29 Rialto, Chicago, Ill.

Boiler Inspectors.

Boiler Plates.
American Steel & Wire Company, Chicago, Ill.
Hartford S. B. I. & Ins. Co., Hartford, Conn.

Boiler-Makers' Tools.
Hammacher, Schlemmer & Co., 209 Bowery, N.Y.
Hilles & Jones Co., Wilmington, Del.
Philadelphia Pneumatic Tool Co., Philadelphia Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.

Bolt Cutters.
Acme Machinery Co., Cleveland, Ohio.
American Tool Works Co., Cincinnati, Ohio.
John M. Rogers, Boat, Gauge and Drill Works, Gloucester City, N. J.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Books.
Henry Carey Baird & Co., 810 Walnut St., Philadelphia, Pa.
Engineering Magazine Press, Ltd., 120-122 Liberty St., New York.
Philadelphia Book Co., Philadelphia, Pa.

Boring Machines.
American Tool Works Co., Cincinnati, Ohio.
The Egan Co., 212-232 West Front St., Cincinnati, Ohio.
J. A. Fay & Co., 271-291 West Front St., Cincinnati, Ohio.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Box Makers' Machinery.
The Egan Co., 212-232 West Front St., Cincinnati, Ohio.
J. A. Fay & Co., 271-291 West Front St., Cincinnati, Ohio.

Bricks.
Henry Maurer & Son, 420 E. 23d St., New York.

Brick and Tile Machinery.
American Blower Co., Detroit, Mich.
F. D. Cummer & Son Co., Cleveland, Ohio.
Harrington & King Perforating Co., Chicago.
Jeffrey Mfg. Co., Columbus, Ohio.

Bridge Builders.
American Bridge Co., New York.
Passaic Rolling Mill Co., Paterson, N. J.

Bridge Pins.
Bethlehem Steel Co., South Bethlehem, Pa.

Bridge Railing.
Chester B. Albree, Allegheny, Pa.

Building Materials.
Chester B. Albree, Allegheny, Pa.
T. H. Brooks Co., Cleveland, Ohio.
Cincinnati Corrugating Co., Piqua, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
H. W. Johns Mfg. Co., 100 William St., N. Y.
Henry Maurer & Son, 420 E. 23d St., New York.
Passaic Rolling Mill Co., Paterson, N. J.
Pittsburg Terra Cotta Lumber Co., Pittsburg, Pa.

By-Pass Valves.
Mason Regulator Co., Boston, Mass.

Cable-Railway Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
R. Poole & Son Co., Baltimore, Md.
Robt. Wetherill & Co., Chester, Pa.

Cables, Electric and Submarine.
American Steel & Wire Company, Chicago, Ill.
Okonite Co., Ltd., 253 Broadway, New York.
John A. Roebling's Sons Co., Trenton, N. J.

Cables, Wire.
American Steel & Wire Co., Chicago, Ill.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Calculating Machines.
Felt & Tarrant Mfg. Co., Chicago, Ill.

Card Index Files.
Rockwell & Rupel Co., 53 La Salle St., Chicago.
The Fred. Macey Co., Grand Rapids, Mich.

Car Brakes.
Dorner Truck & Mfg. Co., Cleveland, Ohio.

Car Shop Machinery.
American Machinery Co., Grand Rapids, Mich.
The Egan Co., 212-232 West Front St., Cincinnati, Ohio.
J. A. Fay & Co., 271-291 W. Front St., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.
Hilles & Jones Co., Wilmington, Del.

Car Truck Springs.
American Steel & Wire Company, Chicago, Ill.

Carriage and Wagon Machinery.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
The Egan Co., 212-232 West Front St., Cincinnati, Ohio.
J. A. Fay & Co., 271-291 W. Front St., Cincinnati, Ohio.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Cast Iron Pipe—See Pipe.

Castings, Iron and Steel.
Aultman Company, Canton, Ohio.
Bethlehem Steel Co., South Bethlehem, Pa.
Edw. P. Allis Co., Milwaukee, Wis.
Stanley G. Flagg & Co., Philadelphia, Pa.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Jeffrey Mfg. Co., Columbus, Ohio.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
S. Morgan Smith Co., York, Pa.
Walworth Manufacturing Co., Boston, Mass.

Cement.
Atlas Portland Cement Co., 143 Liberty St., New York.
Kelley Island Lime and Transport Co., Cleveland, Ohio.

Cement Machinery.
Bethlehem Foundry & Machine Co., South Bethlehem, Pa.
Jeffrey Manufacturing Co., Columbus, Ohio.

Centrifugals.
American Tool & Machine Co., Boston, Mass.
Henry G. Morris, Philadelphia, Pa.

Chain Belting.
Aultman Company, Canton, Ohio.
Buhl Malleable Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, Ohio.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
Link-Belt Engineering Co., Philadelphia, Pa.

Chemicals.
Harrison Bros. & Co., Inc., Philadelphia, Pa.
Roessler & Hasslacher Chemical Co., 100 William St., New York.

Chemical Works Machinery.
Atlantic Works, East Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Chemists—Water and Oil.
Dearborn Drug & Chemical Works, 29 Rialto Chicago, Ill.

Chloride o Lime.
Roessler & Hasslacher Chem. Co., 100 William St., New York.

For Alphabetical Index to Advertisers, see page 23.

Chucks.
American Tool Works Co., Cincinnati, Ohio.

Clay-Working Machinery.
American Blower Co., Detroit, Mich.
Aultman Company, Canton, Ohio.
F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Nicetown, Philadelphia, Pa.
Vulcan Iron Works, Toledo, Ohio.

Coal and Ashes-Handling Machinery.
Aultman Company, Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
Link-Belt Engineering Co., Philadelphia, Pa.
Robins Conveying Belt Co., Park Row Building, New York.

Coal-Mining Machinery.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., 1173 West Lake St., Chicago, Ill.
C. W. Hunt Co., West New Brighton, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
Knowles Steam Pump Works, 91 Liberty St., New York.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
A. Leschen & Sons Rope Co., St. Louis, Mo.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, New York.
Robins Conveying Belt Co., Park Row Building, New York.
Sullivan Machinery Co., Chicago, Ill.
Triumph Electric Co., Cincinnati, Ohio.
Vulcan Iron Works Co., Toledo, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coal Screens.
Borden & Selleck, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Manufacturing Co., Columbus, Ohio.

Coal-Washing Machinery.
Jeffrey Mfg. Co., Columbus, Ohio.

Compressed Air Shop Tools.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Clayton Air Compressor Works, 26 Cortlandt St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.
Knowles Steam Pump Works, 91 Liberty St., New York.
Philadelphia Pneumatic Tool Co., Stephen Girard Bldg., Philadelphia, Pa.
Rand Drill Co., 100 Broadway, New York.
Stow Flexible Shaft Co., Philadelphia, Pa.

Concentrators and Pulverizers.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.

Condensers.
Edw. P. Allis Co., Milwaukee, Wis.
Wm. Baragwanath & Son, Chicago, Ill.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
M. C. Bullock Mfg. Co., 1173 West Lake St., Chicago, Ill.
Deane Steam Pump Co., Holyoke, Mass.
Fraser & Chalmers, Chicago, Ill.
Holly Manufacturing Co., 120 Liberty St., New York.
Knowles Steam Pump Works, 91 Liberty St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Henry R. Worthington, 120 Liberty St., New York.

Contractors' Dump Cars, etc.
Gates Iron Works, Chicago, Ill.
Arthur Koppel, 68 Broad St., New York.

Contractors' Supplies.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Edson Manufacturing Co., Boston, Mass.
Lambert Hoisting Engine Co., Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
Link-Belt Engineering Co., Philadelphia, Pa.
Pelton Engineering Co., Cleveland, Ohio.
Robins Conveying Belt Co., Park Row Building, New York.
Stearns Mfg. Co., Erie, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.

Converters.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Conveying Machinery.
Aultman Company, Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
Buhl Malleable Co., Detroit, Mich.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Engineering Co., Philadelphia, Pa.
John A. Mead Mfg. Co., 3 Broadway, New York.
Robins Conveying Belt Co., Park Row Building, New York.

Copper.
Orford Copper Co., 37 Wall St., New York.

Copper Wire.
American Steel & Wire Company, Chicago, Ill.

Cordage.
American Manufacturing Co., 63 Wall St., New York.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Waterbury Rope Co., 69 South St., New York.

Cranes.
Brown Hoisting & Conveying Machine Co., Cleveland, Ohio.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Wm. Sellers & Co., Philadelphia, Pa.
Whiting Foundry Equipment Co., Harvey, Ill.
R. D. Wood & Co., Philadelphia, Pa.

Crank Pins.
Bethlehem Steel Co., South Bethlehem, Pa.

Crushers—Ore, Phosphate, Rock.
Edw. P. Allis Co., Milwaukee, Wis.
Aultman Company, Canton, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Sturtevant Mill Co., Boston, Mass.

Cupolas.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Whiting Foundry Equipment Co., Harvey, Ill.

Cyanide.
Roessler & Hasslacher Chemical Co., New York.

Damper Regulators.
Mason Regulator Co., Boston, Mass.

Diamond Drills.
American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.
Rand Drill Co., 100 Broadway, New York.
Sullivan Machinery Co., Chicago, Ill.

Diaphragm Pumps.
Edson Manufacturing Co., Boston, Mass.

For Alphabetical Index to Advertisers, see page 23.

Die and Drill Steel.
American Steel & Wire Company, Chicago, Ill.
Hobson, Seaman & Co., 97 John St., New York.
Wm. Jessop & Sons, Ltd., 91 John St., New York.
Walworth Manufacturing Co., Boston, Mass.

Digesters.
Atlantic Works, East Boston, Mass.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Drawing Instruments and Materials.
Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Buff & Buff Mfg Co., 506-510 Atlantic Ave., Boston, Mass.
Eugene Dietzgen Co., 181 Monroe St.,Chicago, Ill.
Keuffel & Esser Co., New York.
Queen & Co., Inc., Philadelphia, Pa.

Dredging Machines.
Atlantic, Gulf & Pacific Co., Park Row Building, New York.
Aultman Company, Canton, Ohio.
A. B. Bowers, San Francisco, Cal.
Bucyrus Co., So. Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Drill Grinder.
Fuller Mfg. Co., Kalamazoo, Mich.

Drills—Rock and Coal.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.
M. C. Bullock Mfg. Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 100 Broadway, New York.
Star Drilling Machine Co., Akron, Ohio.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.
American Tool Works Co., Cincinnati, Ohio.
W. F. & John Barnes Co., Rockford, Ill
Bement, Miles & Co., Philadelphia, Pa.
Bickford Drill and Tool Co., Cincinnati, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Cincinnati Milling Machine Co., Cincinnati, O.
Thos. H. Dallett & Co., Philadelphia, Pa.
Foote, Burt & Co., Cleveland, Ohio.
Fox Machine Co., Grand Rapids, Mich.
Hill, Clarke & Co., Oliver St., Boston, Mass.
Niles Tool Works Co., Hamilton, Ohio.
Norton & Jones Machine Tool Works, Plainville, Conn.
Philadelphia Pneumatic Tool Co., Philadelphia Pa.
Pond Machine Tool Co., Plainfield, N. J.
John M. Rogers, Boat, Gauge and Drill Works, Gloucester City, N. J.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Drop Hammers.
Billings & Spencer Co., Hartford, Conn.

Drying and Calcining Machines.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
F. D. Cummer & Son Co., Cleveland, Ohio.
Gates Iron Works, Chicago, Ill.
Harrison Safety Boiler Works, Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Dump Cars.
Goodwin Car Co., 96 Fifth Ave., New York.

Dynamos.
American Engine Co., Bound Brook, N. J.
C & C Electric Co., 113 Liberty St., New York.
Eddy Electric Mfg. Co., Windsor, Conn.
Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Pelton Engineering Co., Cleveland, Ohio.
Sprague Electric Co., 527 West Thirty-fourth St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Electrical Machinery and Supplies.
American Engine Co., Bound Brook, N. J.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Bristol Co., Waterbury, Conn.
C & C Electric Co., 143 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Eddy Electric Mfg. Co., Windsor, Conn.
Eureka Electric Co., 157 So.Canal St.,Chicago, Ill.
General Electric Co., New York.
Holly Manufacturing Co., 120 Liberty St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Works, 91 Liberty St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Pelton Engineering Co., Cleveland, Ohio.
Snow Steam Pump Works, Buffalo, N. Y.
Sprague Electric Co., 527 West Thirty-fourth St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Tucker Manufacturing Co., York, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Weston Electrical Instrument Co., Newark, N. J.
Henry R.Worthington, 120 Liberty St., New York.

Electric Locomotives.
Baldwin Locomotive Works, Philadelphia, Pa.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
H. K. Porter Co., Pittsburg, Pa.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Electric Railway Builders.
Western Engineering & Construction Co., 15 Cortlandt St., New York.

Electric Wires.
American Steel & Wire Company, Chicago, Ill.

Elevating and Conveying Machinery.
American Tool & Machine Co., Boston, Mass.

Elevator Bucket Dredges.
Vulcan Iron Works Co., Toledo, Ohio.

Elevator Guards and Screens.
Harrington & King Perforating Co., Chicago, Ill.

Elevator Pressure Regulators.
Mason Regulator Co., Boston, Mass.

Elevators.
Aultman Co., Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
Buhl Malleable Co., Detroit, Mich.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
John A. Mead Mfg. Co., 3 Broadway, New York.
R. Poole & Son Co., Baltimore, Md.
Sprague Electric Co., 527 W. Thirty-fourth St., New York.
Triumph Electric Co., Cincinnati, Ohio.
Whiting Foundry Equipment Co., Harvey, Ill.
R. D. Wood & Co., Philadelphia, Pa.

Emery Wheels.
Carborundum Co., Niagara Falls, N. Y.

Emery-Wheel Machinery.
Stow Flexible Shaft Co., Philadelphia, Pa.

Engineers.
Daniel Ashworth, 326 Fourth Ave., Pittsburg, Pa.
A. B. Bowers, San Francisco, Cal.
William M. Brewer, Molson's Bank Building, Vancouver, B. C.
G. M. Brill, 1143-5 Marquette Bldg., Chicago, Ill.
Consolidated Public Works Co., 222 South Third St., Philadelphia, Pa.
Madison Cooper, 410 No. First St., Minneapolis, Minn.
L. B. Darling, 70 Sabin St., Providence, R. I.
W. Dusedau, 36 Pilling St., Brooklyn, N. Y.
S. V. Huber & Co., 702-707 Ferguson Block, Pittsburg, Pa.
Julian Kennedy, Pittsburg, Pa.
David Lamond, 710 Ferguson Block, Pittsburg, Pa.
G. W. McCabe, Son & Co., Smith Block, Pittsburg, Pa.
N. Y. University Testing Laboratory, New York.

For Alphabetical Index to Advertisers, see page 23.

Pelton Engineering Co., Cleveland, Ohio.
C. L. Redfield, 260 Dearborn St., Chicago, Ill.
Sydney F. Reynolds, Torry, Pa.
H. B. Roelker, 41 Maiden Lane, New York.
Stillman & Hall, Ltd., 15 Wall St., New York.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engineering Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Buff & Buff, 506-510 Atlantic Ave., Boston, Mass.
Eugene Dietzgen Co., 181 Monroe St., Chicago, Ill.
Keuffel & Esser Co., New York.
Queen & Co., Inc., Philadelphia, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Fraser & Chalmers, Chicago, Ill.
Sprague Electric Co., 527 W. Thirty-fourth St., New York.

Engines—Gas, Gasoline, and Petroleum.

American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
Fairbanks, Morse & Co., Chicago, Ill.
Giddings & Stevens, Rockford, Ill.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
A. Mietz, 128 Mott St., New York.
Priestman & Co., Bourse Bldg., Philadelphia, Pa.
Struthers, Wells & Co., Warren, Pa.
Weber Gas & Gasoline Engine Co., 428 Southwest Boulevard, Kansas City, Mo.
Westinghouse Machine Co., Pittsburg, Pa
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Marine Iron Works, Station A, Chicago, Ill.

Engines, Stationary.

Edw. P. Allis Co., Milwaukee, Wis.
American Blower Co., Detroit, Mich.
American Engine Co., Bound Brook, N. J.
American Well Works, Aurora, Ill.
Aultman Company, Canton, Ohio.
Ball Engine Co., Erie, Pa.
Buffalo Forge Co., Buffalo, N. Y.
Bullock Mfg. Co., M. C., Chicago, Ill.
Frick Company, Waynesboro, Pa.
Gates Iron Works, Chicago, Ill.
Harrisburg Foundry and Machine Co., Harrisburg, Pa.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
New York Safety Steam Power Co., 107 Liberty St., N. Y.
Star Drilling Machine Co., Akron, Ohio.
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass
Webster, Camp & Lane Machine Co., Akron, Ohio.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Robert Wetherill & Co., Chester, Pa.

Engravers.

A. Mugford, 120 Liberty St., New York.

Excavators.

Atlantic, Gulf & Pacific Co., Park Row Building, New York.
Aultman Company, Canton, Ohio.
A. B. Bowers, San Francisco, Cal.
Bucyrus Co., So. Milwaukee, Wis.
Edson Manufacturing Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
A. Leschen & Sons Rope Co., St. Louis, Mo.
Marion Steam Shovel Co., Marion, Ohio.
Odorless Excavating Co., Boston, Mass.
Robins Conveying Belt Co., Park Row Building, New York.
Vulcan Iron Works, Toledo, Ohio.

Exhaust Heads.

Direct Separator Co., Syracuse, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Fans, Ventilating.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., 1173 West Lake St., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
Pelton Engineering Co., Cleveland, Ohio.
Sprague Electric Co., 527 W. Thirty-fourth St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Feed-Water Heaters and Purifiers.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
Goubert Mfg. Co., 14 Church St., New York.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Wm. S. Haines Co., Philadelphia, Pa.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Ross Valve Co., Troy, N. Y.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Taunton Locomotive Mfg. Co., Taunton, Mass.
Robt. Wetherill & Co., Chester, Pa.

Ferro-Silicon.

Carborundum Co., Niagara Falls, N. Y.

Fertilizer Machinery.

Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Nicetown, Philadelphia, Pa.

Files and Rasps.

G. & H. Barnett Co., Philadelphia, Pa.

Filters.

New York Filter Mfg. Co., 15 Broad St., New York.

Fire Extinguishing Apparatus.

International Sprinkler Co., Philadelphia, Pa.

Flanges.

Latrobe Steel Co., 1200 Girard Bldg., Philadelphia, Pa.

Flexible Shafts.

Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Union Boiler Tube Cleaner Co., Pittsburg, Pa.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Flour-Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.

Flue Cleaners.

Union Boiler Tube Cleaner Co., Pittsburg, Pa.

Flue Cutters and Rollers.

Philadelphia Pneumatic Tool Co., Philadelphia, Pa.

Flushometer.

Kenney Co., 72-74 Trinity Place, New York.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Fraser & Chalmers, Chicago, Ill.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
R. Poole & Son Co., Baltimore, Md.
S. Morgan Smith Co., York, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Force Pumps.

Edson Manufacturing Co., Boston, Mass.

Forges.

Buffalo Forge Co., Buffalo, N. Y.

For Alphabetical Index to Advertisers, see page 23.

B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Forgings, Iron and Steel.

Chester B. Albree, Allegheny, Pa.
Bethlehem Steel Co., South Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Strieby & Foote, Newark, N. J.
Wyman & Gordon, Worcester, Mass.

Foundry Equipment.

Whiting Foundry Equipment Co., Harvey, Ill.

Friction Clutches.

Christiana Machine Co., Christiana, Pa.
Eastern Machinery Co., New Haven, Conn.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
Link-Belt Engineering Co., Nicetown, Philadelphia, Pa.
R. Poole & Son Co., Baltimore, Md.
Reeves Pulley Co., Columbus, Ind.
S. Morgan Smith Co., York, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Furnace Builders.

American Gas Furnace Co., 23 John St., New York
Julian Kennedy, Pittsburg, Pa.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Whiting Foundry Equipment Co., Harvey, Ill.

Furniture.

Rockwell & Rupel Co., 53 La Salle St., Chicago.
The Fred. Macey Co., Grand Rapids, Mich.

Gages—Pressure, Steam, Water, etc.

Bristol Co., Waterbury, Conn.
Hohman & Maurer Mfg. Co., 53 Elizabeth St., Rochester, N. Y.
Walworth Manufacturing Co., Boston, Mass.

Gas Exhausters.

B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Gas Fixtures.

Walworth Manufacturing Co., Boston, Mass.

Gas Holders.

Riter-Conley Mfg. Co., Pittsburg, Pa.
United Gas Improvement Co., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Gas Machines and Generators.

American Gas Furnace Co., 23 John St., N. Y.
Link-Belt Machinery Co., Nicetown, Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.
United Gas Improvement Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Gate Valves.

Jenkins Bros., 71 John St., New York.
The Lunkenheimer Co., Cincinnati, Ohio.
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Hugo Bilgram, 440 No. 12th St., Philadelphia, Pa.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Borden & Selleck Co., Chicago, Ill.
Christiana Machine Co., Christiana, Pa.
Jeffrey Mfg Co., Columbus, Ohio.
Knowles Steam Pump Works, 91 Liberty St., New York.
Morse, Williams & Co., Philadelphia, Pa.
New Process Rawhide Co., Syracuse, N. Y.
R. Poole & Son Co., Baltimore, Md.
William Sellers & Co., Inc., Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
The Stilwell-Bierce & Smith-Vaile Co., Dayton, O.

Girders.

Chester B. Albree, Allegheny, Pa.
Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Passaic, N. J.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Aultman Company, Canton, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.
Riter-Conley Mfg. Co., Pittsburg, Pa.
Robins Conveying Belt Co., Park Row Building, New York.

Grates.

Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.

American Tool Works Co., Cincinnati, Ohio.
Landis Tool Co., Waynesboro, Pa
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.

Hangers—See Pulleys.

Heating and Ventilating Apparatus.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Sprague Electric Co., 527 W. Thirty-fourth St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.

Heaters, Steam and Hot Water.

A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
H. B. Smith Co., 137 Center St., New York.
Walworth Manufacturing Co., Boston, Mass.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Aultman Company, Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
Brown Hoisting & Conveying Machine Co., Cleveland, Ohio.
M. C. Bullock Mfg. Co., 1173 West Lake St., Chicago, Ill.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
C. W. Hunt Co., West New Brighton, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Link-Belt Engineering Co., Nicetown, Philadelphia, Pa.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Stearns Manufacturing Co., Erie, Pa.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Weber Gas & Gasoline Engine Co., 428 Southwest Boulevard Kansas City, Mo.
Webster, Camp & Lane Machine Co., Akron, O.

Hollow Bricks.

Henry Maurer & Son, 420 E. 23d St., New York.

Hollow Chisel Mortisers.

The Egan Co., 212-232 West Front St., Cincinnati, Ohio.
J. A. Fay & Co., 271-291 West Front St., Cincinnati, Ohio.

Hose.

Eureka Fire Hose Co., 13 Barclay St., New York.

Hydrants.

R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Machinery.

Christiana Machine Co., Christiana, Pa.
John H. McGowan Co., Cincinnati, Ohio.
S. Morgan Smith Co., York, Pa.
R. Poole & Son Co., Baltimore, Md.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Watson & Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making and Refrigerating Machinery.

Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Frick Company, Waynesboro, Pa.
Holly Manufacturing Co., 120 Liberty St., New York.
Knowles Steam Pump Works, 91 Liberty St., New York.

For Alphabetical Index to Advertisers, see page 23.

Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
H. B. Roelker, 41 Maiden Lane, New York.
Snow Steam Pump Works, Buffalo, N. Y.
Stilwell, Bierce & Smith-Vaile Co., Dayton, O.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.
Henry R. Worthington, 120 Liberty St., New York.

Incandescent Lamps—(See Lamps, Electric.)

Industrial Railways.
Borden & Selleck Co., Chicago, Ill.
C. W. Hunt Co., West New Brighton, New York.
Whiting Foundry Equipment Co., Harvey, Ill.
Arthur Koppel, 68 Broad St., New York.

Injectors.
American Injector Co., Detroit, Mich.
The Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.

Insulated Wire.
American Steel & Wire Company, Chicago, Ill.
Central Electric Co., 265-269 Fifth Ave., Chicago, Ill.
Okonite Co., Ltd., 253 Broadway, New York.
John A. Roebling's Sons Co., Trenton, N. J.
Sprague Electric Co., 527 W. Thirty-fourth St., New York.

Iron.
Passaic Rolling Mill Co., Paterson, N. J.

Kerosene Engines.
A. Mietz, 128 Mott St., New York.

Kiers.
Atlantic Works, East Boston, Mass.

Kyanizing.
Otis Allen & Son, Lowell, Mass.

Lace Leather.
Chas. A. Schieren & Co., 45-51 Ferry St., New York.

Lag Screws.
Sam'l Hall's Sons, 229-233 W. Tenth St., New

Lamps, Electric.
Fort Wayne Electric Works, Ft. Wayne, Ind.
General Incandescent Lamp Co., Cleveland, Ohio.
Lea Manufacturing Co., Elwood, Ind.
Pelton Engineering Co., Cleveland, Ohio.
Sawyer-Man Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.
American Tool Works Co. Cincinnati, Ohio.
U. Baird Machinery Co., Pittsburg, Pa.
W. F. & John Barnes Co., Rockford, Ill.
Bement, Miles & Co., Philadelphia, Pa.
Cincinnati Milling Machine Co., Cincinnati, O.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Launches—Steam, Naphtha, etc.
Marine Iron Works, Station A, Chicago, Ill.

Leather, Hydraulic, Valve and Pump.
Chas. A. Schieren & Co., 45-51 Ferry St., New York.

Leather Link-Belting.
Chas. A. Schieren & Co., 45-51 Ferry St., New York.

Lever Valves.
Mason Regulator Co., Boston, Mass.

Link Belting.
Buhl Malleable Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, Ohio.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
Link-Belt Engineering Co., Philadelphia, Pa.

Locomotives.
Baldwin Locomotive Works, Philadelphia, Pa.
Dickson Mfg. Co., Scranton, Pa.
Pittsburg Locomotive Works, Pittsburg, Pa.
H. K. Porter Co., Pittsburg, Pa.
Stearns Manufacturing Co., Erie, Pa.

Locomotive Brakes.
Westinghouse Air Brake Co., Pittsburg, Pa.

Locomotive Cranes.
Bucyrus Co., So. Milwaukee, Wis.

Logging Outfits.
A. Leschen & Sons Rope Co., St. Louis, Mo.

Lubricants.
Jos. Dixon Crucible Co., Jersey City, N. J.

Machine Screws.
Sam'l Hall's Sons, 229-233 W. 10th St., New York.
Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.
Acme Machinery Co., Cleveland, Ohio.
American Tool Works Co., Cincinnati, O.
U. Baird Machinery Co., Pittsburg, Pa.
W. F. & John Barnes Co., Rockford, Ill.
Bement, Miles & Co., Philadelphia, Pa.
Billings & Spencer Co., Hartford, Conn.
Cincinnati Milling Machine Co., Cincinnati, O.
Cincinnati Shaper Co., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.
Hammacher, Schlemmer & Co., 209 Bowery, N.Y.
Hill, Clarke & Co., Oliver St., Boston, Mass.
Hilles & Jones Co., Wilmington, Del.
Jones & Lamson Machine Co., Springfield, Vt.
Niles Tool Works Co. Hamilton, O.
Norton & Jones Machine Tool Works, Plainville, Conn.
Pond Machine Tool Co., Plainfield, N. J.
Wm. Sellers & Co., Philadelphia, Pa.
Stearns Manufacturing Co., Erie, Pa.
Stow Flexible Shaft Co., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Walworth Manufacturing Co., Boston, Mass.
Warner & Swasey, Cleveland, Ohio.
Worcester Machine Screw Co., Worcester, Mass.

Malleable Castings.
Buhl Malleable Co., Detroit, Mich.

Manganese Bronze.
Paul S. Reeves & Son, Philadelphia, Pa.

Marine Boilers.
Marine Iron Works, Station A, Chicago, Ill.
Thorpe, Platt & Co., 97 Cedar St., New York.

Marine Machinery.
Lambert Hoisting Engine Co., Newark, N. J.
Marine Iron Works, Station A, Chicago, Ill.

Marine Ropes (Iron and Steel).
American Steel & Wire Company, Chicago, Ill.

Mathematical Instruments.
Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Queen & Co., Inc., Philadelphia, Pa.

Mechanical Draft.
American Blower Co., Detroit, Mich.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Westinghouse, Church, Kerr & Co., 26 Cortlandt St., New York.

Metallic Gaskets.
Bethlehem Foundry & Machine Co., South Bethlehem, Pa.

Metallic Packing.
United States Metallic Packing Co., Philadelphia, Pa.

Meters, Electric.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Milling Machines—(see Machine Tools and Supplies.)

Milling Tools.
John M. Rogers, Boat, Gauge and Drill Works, Gloucester City, N. J.

Mine Cars.
M. C. Bullock Mfg. Co., 1173 West Lake St., Chicago, Ill.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.

For Alphabetical Index to Advertisers, see page 23.

C. W. Hunt Co., West New Brighton, New York.
Jeffrey Manufacturing Co., Columbus, Ohio.
Arthur Koppell, 68 Broad St., New York.
Whiting Foundry Equipment Co., Harvey, Ill.

Mine Haulage Rope.
A. Leschen & Sons Rope Co., St. Louis, Mo.

Mining Machinery.
Edw. P. Allis Co., So. Milwaukee, Wis.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
M. C. Bullock Mfg. Co., 1173 West Lake St., Chicago, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Edson Manufacturing Co., Boston Mass.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Holly Manufacturing Co., 120 Liberty St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
Knowles Steam Pump Works, 91 Liberty St., New York.
Arthur Koppel, 68 Broad St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, New York.
Robins Conveying Bel Co., Park Row Building, New York.
F. L. Smidth & Co., 66 Maiden Lane, New York.
Snow Steam Pump Works, Buffalo, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Works Co., Toledo, Ohio.
Weber Gas & Gasoline Engine Co., 428 Southwest Boulevard, Kansas City, Mo.
Webster, Camp & Lane Machine Co., Akron, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Henry R. Worthington, 120 Liberty St., New York.

Mining Screens—See Screens.

Motors, Electric.
American Engine Co., Bound Brook, N. J.
C & C Electric Co., 145 Liberty St., New York.
Eddy Electric Mfg. Co., Windsor, Conn.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Pelton Engineering Co., Cleveland, Ohio.
Sprague Electric Co., 527 West Thirty-fourth St., New York.
B. F. Sturtevant Co., Jamaica Plain Station, Boston, Mass.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Motor Springs.
American Steel & Wire Company, Chicago, Ill.

Multiple Drills.
Bickford Drill and Tool Co., Cincinnati, Ohio.
Foote, Burt & Co., Cleveland, Ohio.

Naphtha Gas Machines.
American Gas Furnace Co., 23 John St., N. Y.

Nickel.
Orford Copper Co., 37 Wall St., New York.

Nickel-Steel.
Bethlehem Steel Co., South Bethlehem, Pa.

Oil Cups.
The Lunkenheimer Co., Cincinnati, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Oil Extractors.
Direct Separator Co., Syracuse, N. Y.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.

Oil-Gas Plants.
American Gas Furnace Co., 23 John St., N. Y.

Oil Separators.
American Tool Works Co., Cincinnati, Ohio.
A. A. Griffing Iron Co., 66-68 Centre St., New York; Works, Jersey City.
Harrison Safety Boiler Works, Philadelphia, Pa.

Oil Stones.
American Machinery Co., Grand Rapids, Mich.

Open Hearth Furnaces.
G. W. McClure, Son & Co., Smith Block, Pittsburg, Pa.

Ore-Roasting Machinery.
F. D. Cummer & Son Co., Cleveland, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.

Ore Screens.
Jeffrey Manufacturing Co., Columbus, Ohio.
Harrington & King Perforating Co., Chicago, Ill.

Packing.
Jenkins Brothers, 71 John St., New York.
United States Metallic Packing Co., Philadelphia, Pa.

Paddle-Wheel Machinery.
Marine Boiler Works, Station A, Chicago, Ill.

Paints.
Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.
Harrison Bros. & Co., Inc., Philadelphia, Pa.
H.W. Johns Mfg. Co., 100 William St., New York.

Paper-Mill Machinery.
Aultman Company, Canton, Ohio.
Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Holly Manufacturing Co., 120 Liberty St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Knowles Steam Pump Works, 91 Liberty St., New York.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Robins Conveying Belt Co., Park Row Building, New York.
Snow Steam Pump Works, Buffalo, N. Y.
Robt. Wetherill & Co., Chester, Pa.
Henry R. Worthington, 120 Liberty St., New York.

Park Benches.
Bethlehem Foundry & Machine Co., South Bethlehem, Pa.

Patent Attorneys.
Victor J. Evans & Co., Evans Building, Washington, D. C.
The Patent Record, Baltimore, Md.

Pattern-Makers' Machinery.
American Machinery Co., Grand Rapids, Mich.
The Egan Co., 212-232 West Front St., Cincinnati, Ohio.
J. A. Fay & Co., 271-291 West Front St., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.

Penstocks.
Atlantic Works, East Boston, Mass.
Riter-Conley Mfg. Co., Pittsburg, Pa.

Perforated Metals.
Fraser & Chalmers, Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Harrington & King Perforating Co., Chicago, Ill.

Peroxide of Sodium.
Roessler & Hasslacher Chemical Co., New York.

Phosphor Bronze.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.
Paul S. Reeves & Son, Philadelphia, Pa.

Photographic Supplies.
Queen & Co., Inc., Philadelphia, Pa.

Pile Drivers.
Bucyrus Co., So. Milwaukee, Wis.

Pipe, Cast-Iron.
Abendroth & Root Mfg. Co., 99 John St., N. Y.
Fairbanks, Morse & Co., Chicago, Ill.
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.
U. S. Cast Iron Pipe & Fdy. Co., Philadelphia, Pa.

Pipe Cleaners.
Union Boiler Tube Cleaner Co., Pittsburg, Pa.

Pipe Coverings.
Michigan Pipe Co., Bay City, Mich.

For Alphabetical Index to Advertisers, see page 23.

Pipe-Cutting and Threading Machines.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Cox & Sons Company, Bridgeton, N. J.
Walworth Manufacturing Co., Boston, Mass.

Pipe Fittings, Cast-Iron.
Fairbanks, Morse & Co., Chicago, Ill.
Walworth Manufacturing Co., Boston, Mass.

Pipe Foundry Equipment.
Whiting Foundry Equipment Co., Harvey, Ill.

Pipe, Wrought-Iron and Steel.
Shelby Steel Tube Co., Cleveland, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Piston Rods.
Bethlehem Steel Co., South Bethlehem, Pa.

Placer Mining Machinery.
Bucyrus Co., So. Milwaukee, Wis.
Edson Manufacturing Co., Boston, Mass.
Vulcan Iron Works Co., Toledo, Ohio.

Planers.
American Tool Works Co., Cincinnati, Ohio.
U. Baird Machinery Co., Pittsburg, Pa.
Bement, Miles & Co., Philadelphia, Pa.
Cincinnati Milling Machine Co., Cincinnati, O.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Planing Mill Machinery.
American Machinery Co., Grand Rapids, Mich.
The Egan Co., 212-232 West Front St., Cincinnati, Ohio.
J. A. Fay & Co., 271-291 West Front St., Cincinnati, Ohio.
Fox Machine Co., Grand Rapids, Mich.

Platinum Ware.
J. C. Entriken, Malvern, Pa.

Plumbers' Tools and Supplies.
Walworth Manufacturing Co., Boston, Mass.

Pneumatic Tools.
Philadelphia Pneumatic Tool Co., Philadelphia, Pa.

Portable Railways.
C. W. Hunt Co., West New Brighton, New York.
Arthur Koppel, 68 Broad St., New York.

Power Hammers.
Bement, Miles & Co., Philadelphia, Pa.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Power-Transmission Machinery.
Aultman Company, Canton, Ohio.
Christiana Machine Co., Christiana, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
Link-Belt Engineering Co., Philadelphia, Pa.
Robins Conveying Belt Co., Park Row Building, New York.
S. Morgan Smith Co., York, Pa.
Sprague Electric Co., 527 W. Thirty-fourth St., New York.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Preservation of Lumber.
Otis Allen & Son, Lowell, Mass.

Presses and Dies.
Ferracute Machine Co., Bridgeton, N. J.

Presses, Hydraulic, etc.
Watson & Stillman Co., 210 East 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Propeller Wheels.
Marine Iron Works, Station A, Chicago, Ill.

Prospecting Drills.
American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., 1173 West Lake St., Chicago, Ill.
Star Drilling Machine Co., Akron, Ohio.
Sullivan Machinery Co., Chicago, Ill.

Pulleys, Shafting and Hangers.
Edw. P. Allis Co., Milwaukee, Wis.
American Steel & Wire Company, Chicago, Ill.
Aultman Company, Canton, Ohio.
Borden & Selleck Co., Chicago, Ill.
Christiana Machine Co., Christiana, Pa.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
W. A. Jones Foundry and Machine Co., 53-59 So. Jefferson St., Chicago, Ill.
R. Poole & Son Co., Baltimore, Md.
Reeves Pulley Co., Columbus, Ind.
Robins Conveying Belt Co., Park Row Building, New York.
Wm. Sellers & Co., Philadelphia, Pa.
S. Morgan Smith Co., York, Pa.
Stilwell-Bierce & Smith-Vaile Co., Dayton, O.
Robert Wetherill & Co., Chester, Pa

Pulverizers.
Fraser & Chalmers, Chicago, Ill.
Jeffrey Manufacturing Co., Columbus, Ohio.
Sturtevant Mill Co., Boston, Mass.

Pump Governors.
Mason Regulator Co., Boston, Mass.

Pump Pressure Regulators.
Mason Regulator Co., Boston, Mass.

Pumps and Pumping Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
The Geo. F. Blake Mfg. Co., 91 Liberty St., New York.
Bucyrus Co., So. Milwaukee, Wis.
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Pulsometer Steam Pump Co., 120 Liberty St., New York.
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Snider-Hughes Co., Cleveland, Ohio.
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Fox Machine Co., Grand Rapids, Mich.
Fuller Mfg. Co., Kalamazoo, Mich.
Hilles & Jones Co., Wilmington, Del.
Niles Tool Works Co., Hamilton, O.
Pond Machine Tool Co., Plainfield, N. J.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

For Alphabetical Index to Advertisers, see page 23.

Quarrying Machinery.
A. S. Cameron Steam Pump Works, E. 23d St., New York.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
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H. B. Smith Co., 137 Centre St., New York.

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Jeffrey Mfg. Co., Cleveland, Ohio.
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American Steel & Wire Company, Chicago, Ill.
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Harrington & King Perforating Co., Chicago, Ill.
Hendrick Mfg. Co., Ltd., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, Ohio.

For Alphabetical Index to Advertisers, see page 23.

W. A. Jones Fdy. & Mch. Co., 53-59 So. Jefferson St., Chicago, Ill.
Robins Conveying Belt Co., Park Row Building, New York.

Screw Machines.
American Tool Works Co., Cincinnati, Ohio.
Cincinnati Milling Machine Co., Cincinnati, O.
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Union Boiler Tube Cleaner Co., Pittsburg, Pa.

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Shafting (see Pulleys).

Shafting (Cold Drawn Steel).
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Shapers.
American Tool Works Co., Cincinnati, Ohio.
U. Baird Machinery Co., 723-725 Water St., Pittsburg, Pa.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cincinnati Shaper Co., Cincinnati, Ohio.
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For Alphabetical Index to Advertisers, see page 23.

Tenoning Machines.
The Egan Co., 212-232 West Front St., Cincinnati, Ohio.
J. A. Fay & Co., 271-291 West Front St., Cincinnati, Ohio.

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Wm. Sellers & Co., Philadelphia, Pa.

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Snow Steam Pump Works, Buffalo, N. Y.
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For Alphabetical Index to Advertisers, see page 23.

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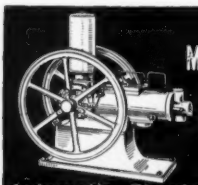

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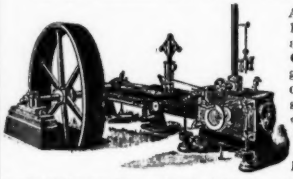

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ALPHABETICAL INDEX TO ADVERTISERS

Abendroth & Root Mfg. Co. ... 100
Acme Machinery Co. ... —
Adams Co. ... 95
Albree Iron Works, Chester B. ... 94
Allen & Son, Otis ... 84
Allis Co., Edw. P. ... 70
Alsop, E. C. ... 28
Alteneder & Sons, Theo. ... 27
American Blower Co. ... 25
American Bridge Co. ... 99
American Engine Co. ... 69
American Gas Furnace Co. ... 4
American Injector Co. ... 82
American Machinery Co. ... 97
American Manufacturing Co. ... 102
American Tool & Machine Co. ... 100
American Tool Works Co. ... 2
American Well Works ... 53
American Steel & Wire Co. ... 67
Armstrong Mfg. Co. ... 94
Ashworth, Daniel ... 28
Atlantic Works ... 73
Atlantic, Gulf & Pacific Co. ... 21
Atlas Portland Cement Co. ... 7
Aultman Co. ... 63
Austin Separator Co. ... 77

Baird & Co., Henry Carey ... 22
Baldwin Locomotive Works ... 85
Ball Engine Co. ... 70
Barnes Co., W. F. & John ... 93
Barnett Co., G. & H. ... 2
Bethlehem Foundry & Machine Co. ... 94
Bethlehem Steel Co. ... 71
Bickford Drill & Tool Co. ... 92
"Big Four" Route ... 26
Bignall & Keeler Mfg. Co. ... 94
Bilgram, Hugo ... 88
Billings & Spencer Co. ... 6
Blake Mfg. Co., George F. ... 52
Borden & Selleck Co. ... 61
Bowers, A. B. ... 21
Brandis Sons Co. ... 27
Brewer, W. M. ... 29
Brill, Geo. M. ... 28
Bristol Company ... 34
Brooks & Co., T. H. ... 97
Brown Hoisting & Conveying Machine Co. ... 58
Buckeye Electric Co. ... 47
Bucyrus Co. ... 3
Buff & Buff Mfg. Co. ... 27
Buffalo Forge Co. ... 34
Buhl Malleable Co. ... 63
Bullock Mfg. Co., M. C. ... 58

C & C Electric Co. ... 48
Caldwell Co., W. E. ... 54
Cameron Steam Pump Works, A. S. ... 51
Carborundum Co. ... 88
Carlin's Sons Co., Thos. ... 64
Chicago Boiler Cleaner Co. ... 22-71
Christiana Machine Co. ... 54
Churchill & Co., Charles ... —
Cincinnati Milling Machine Co. ... —
Cincinnati Shaper Co. ... 91
Clayton Air Compressor Works ... 3
Cleveland Ball & Screw Co. ... 90
Clonbrock Steam Boiler Co. ... 73
"Compressed Air" ... 30
Consolidated Public Works Co., Inc. ... 28
Contractors' Plant Mfg. Co. ... 64
Cooper, Hewitt & Co. ... 62
Cox & Sons Co. ... 71
Crosby Steam Gauge & Valve Co. ... 3
Cummer & Son Co., F. D. ... 21

Dallett & Co., Thos. H. ... 92
Darling, L. B. ... 28
Darrach, Chas. G. ... 28
Davis, Johnson & Co. ... 50
Deane Steam Pump Co. ... 51
Dearborn Drug & Chemical Works ... 76
Detroit Graphite Mfg. Co. ... 34
Dietzgen Co., Eugene ... 27
Direct Separator Co. ... 82
Dixon Crucible Co., Joseph ... 7
Dorner Truck & Mfg. Co. ... 84
Dusedau, W. ... 29

Egan Company, The ... —
Eastern Machinery Co. ... 74
Eddy Electric Mfg. Co. ... 49
Edson Mfg. Co. ... 53
Entriken, J. C. ... 59
Eureka Electric Co. ... 49
Evans & Co., Victor J. ... 30

Fairbanks, Morse & Co. ... 4
Fay & Co., J. A. ... 97
Felt & Tarrant Mfg. Co. ... —
Ferracute Machine Co. ... 92
Flagg & Co., Stanley G. ... 102
Foote, Burt & Co. ... 92
Fox Machine Co. ... 97
Fraser & Chalmers ... 56
Frick Company ... 73

Gates Iron Works ... 59
General Electric Co. ... 25
General Incandescent Lamp Co. ... 49
Giddings & Stevens ... 22
Goodwin Car Co. ... 83
Goubert Mfg. Co. ... 82
Green Fuel Economizer Co. ... 81
Griffing Iron Co., A. A. ... 75
Guild & Garrison ... 43

Haines Co., Wm. S. ... 86
Harrington & King Perforating Co. ... 60
Harrisburg Foundry & Mach. Works ... 69
Harrison Bros. & Co., Inc. ... 22
Harrison Safety Boiler Works ... 76
Hartford Steam Boiler Inspection & Ins. Co. ... 6
Harvard University ... 31
Heine Safety Boiler Co. ... 73
Herrick, Albert B. ... 29
Hill, Clarke & Co. ... 92
Hilles & Jones Co. ... 96
Hobson, Houghton & Co. ... 90
Hohmann & Maurer Mfg. Co. ... 80
Holly Manufacturing Co. ... 52
Holtzer-Cabot Electric Co. ... 72
Hooven, Owens & Rentschler Co. ... 70
Hoppes Mfg. Co. ... 76
Howard Iron Works ... 91
Huber & Co., S. V. ... 30
Hunt Co., C. W. ... 66

Illinois Central R. R. ... 26
Ingersoll-Sergeant Drill Co. ... 55
International Correspondence Schools ... 31
International Sprinkler Co. ... 98

Jandus Electric Co. ... 47
Jeffrey Mfg. Co. ... 64
Jenkins Bros. ... 102
Jessop & Sons, Ltd., Wm. ... 90
Jewell Filter Co., O. H. ... 4
Johns Mfg. Co., H. W. ... 3
Jones & Lamson Machine Co. ... 91
Jones Fdy. & Machine Co., W. A. ... 74

Kelly Island Lime & Transport Co. ... 21
Kelly Co., O. S. ... 2
Kennedy, Julian ... 29
Keuffel & Esser Co. ... 27
Keystone Law & Patent Co. ... 30
Knowles Steam Pump Works ... 50
Koppel, Arthur ... 84

Laidlaw-Dunn-Gordon Co. ... 51
Lambert Hoisting Engine Co. ... 64
Lamond, David ... 28
Landis Tool Co. ... 96
Latrobe Steel Co. ... 90
Lea Electric Manufacturing Co. ... —
Leffel & Co., James ... 43
Leschen & Sons Rope Co., A. ... 61
Lidgerwood Mfg. Co. ... 101
Link-Belt Engineering Co. ... 65
Lunkenheimer Co. ... 78

McClure, Son & Co., G. W. ... 30
McCrea & Co., James ... 78
McGill University ... 31
McGowan Co., John H., The ... 52
Macey Co., Fred ... 27
Main Belting Co. ... 77
Manufacturers' Advertising Bureau ... 100
Marine Iron Works ... 77
Marion Steam Shovel Co. ... 3
Mason Regulator Co. ... 74
Massachusetts Inst. of Technology ... 31
Maurer & Son, Henry ... 98
Merrell Mfg. Co. ... 27
Merrill Pneumatic Pump Co. ... 51
Michigan College of Mines ... 30
Michigan Pipe Co. ... 52
Meitz, A. ... 22
Morris, Henry G. ... 7
Morrow, P. C. ... 30
Morse, Williams & Co. ... 88
Mugford, A. ... 26

New Process Rawhide Co..... 88
New York Central R. R..... 26
New York Filter Mfg. Co..... 4
N. Y. Safety Steam Power Co..... 81
Niles Tool Works Co..... 87
Norwalk Iron Works Co..... 57

Odorless Excavating Co..... 4
Okonite Co., Ltd..... 43
Orford Copper Co..... 90

Partridge Carbon Works..... 49
Passaic Rolling Mill Co..... 34
Patent Record..... 30
Pelton Engineering Co..... 28
Pelton Water Wheel Co..... 22
Penberthy Injector Co..... 79
Philadelphia Book Co..... 24
Philadelphia Pneumatic Tool Co..... 96
Phosphor Bronze Smelting Co., Ltd..... 74
Pittsburg Locomotive Works..... 85
Pittsburg Meter Co..... 50
Pneumatic Engineering Co..... 50
Poole & Son Co., R..... 88
Porter Co., H. K..... 85
Powell Co., Wm..... 82
Pratt Institute..... 30
Priestman Co., Inc..... 72
Produce Refrigerating Co..... 29
Purdue University..... 31
Pulsometer Steam Pump Co..... 51

Queen & Co., Inc..... 7
Quimby, Wm. E..... 100

Rand Drill Co..... 56
Reeves & Son, Paul S..... 90
Redfield, C. L..... 29
Rensselaer Polytechnic Inst..... 30
Reynolds, Sidney F..... 29
Richmond Locomotive & Machine Works..... 86
Riter-Conly Manufacturing Co..... 25
Robins Conveying Belt Co..... 63
Rockwell & Rupel Co..... 8
Roebling's Sons Co., John A..... 62
Roelker, H. B..... 28
Roessler & Hasslacher Chemical Co..... 56
Rogers Boat, Gauge & Drill Works, John M.. 55
Ross Valve Co..... 74
Roth Bros. & Co..... 48

Schieren & Co., Chas. A..... 75
Scranton Steam Pump Co..... 53
Sears, Roebuck & Co..... 27
Sellers & Co., Wm..... 95
Scheffield Scientific School..... 31
Shelby Steel Tube Co..... 89
Smidth & Co., F. L..... 59
Smith Co., H. B..... 98
Smith Co., S. Morgan..... 54
Snider-Hughes Co..... 52
Snow Steam Pump Works..... 52
Southwark Foundry & Machine Co..... 69
Sprague Electric Co..... 49
Star Drilling Machine Co..... 53
Stearns Manufacturing Co..... 85
Stevens Institute of Technology..... 31
Stillman & Hall..... 29
Stilwell-Bierce & Smith-Vaile Co..... 54
Stirling Co..... 102
Stocking, E. B..... 30
Stow Flexible Shaft Co..... 95
Stow Manufacturing Co..... 95
Strieby & Foote Co..... 95
Struthers, Wells & Co..... 72
Sturtevant Co., B. F..... 68
Sturtevant Mill Co..... 57
Sullivan Machinery Co..... 57

Testing Laboratory, New York University.... 28
Thayer School of Civil Engineering..... 30
Thorpe, Platt & Co..... 73
Trenton Iron Co..... 62
Triumph Electric Co..... 24
Tucker Mfg. Co..... 49

Underwood & Co., H. B..... 78
U. S. Cast Iron Pipe & Foundry Co..... 93
U. S. Metallic Packing Co..... 8

Van Slooten, Wm..... 29
Vermont University..... 31
Vulcan Iron Works..... 4

Walworth Manufacturing Co..... 7
Warner & Swasey..... 8
Waterbury Rope Co..... 61
Watson-Stillman Co..... 93
Weber Gas & Gasoline Engine Co..... 72
Webster, Camp & Lane Machine Co..... 58
Weis & Gibson..... 29
Wellman-Seaver Engineering Co..... 29
Western Engineering and Construction Co., The 48
Westinghouse Air Brake Co..... 44
Westinghouse, Church, Kerr & Co..... 45
Westinghouse Electric & Mfg. Co..... 45
Westinghouse Machine Co..... 45
Weston Electric Instrument Co..... 43
Wetherill & Co., Robt..... 34
Whiting Foundry Equipment Co..... 97
Williams Brothers..... 50
Wisconsin University..... 31
Wood & Co., R. D..... 93
Worcester Machine Screw Co..... 91
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Worcester Polytechnic Institute..... 31
Wyman & Gordon..... 102

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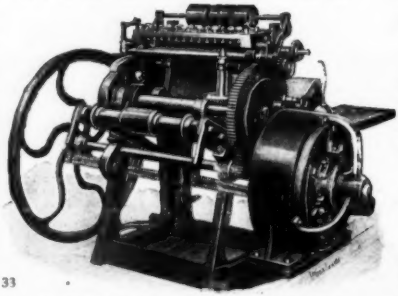

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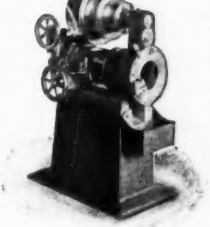

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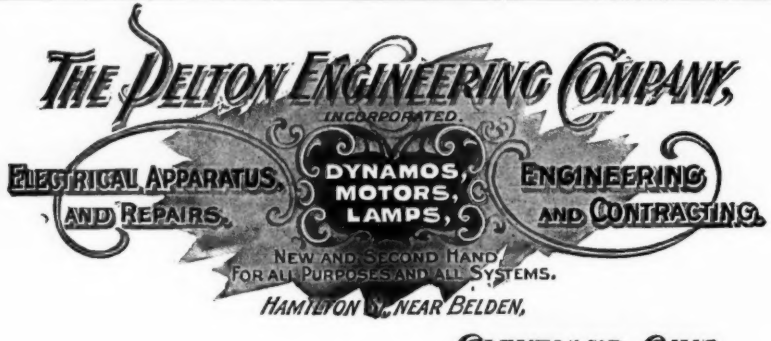

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5. The Accountant.
6. The Cashier.
7. Correspondence Clerk.
8. Supplies' Orders and Invoices.
9. Customers' Orders and Invoices.
10. Drawing Office.
11. Estimating.
12. Stationery.
13. Advertising and Catalogues.
14. The Works Manager.
15. The Inspector.
16. The Entrance Gates and the Gatekeeper.
17. The Stores and Storekeeper.
18. The Warehouse and Warehouseman.
19. Carriage.
20. The Foremen.
21. The Time-keeper and Job Clerk.
22. The Paying of Wages.
23. Establishment Charges.
24. Stock Surveys.
25. Diagrams and Curves.
26. Diagrams of Manufacturing Accounts and Balance Sheets.
27. General View of Manufacturing Accounts.
28. Synopsis of Transactions Relating to Purchases and Stores.
29. Synopsis of Transactions Relating to Labor and Time.
30. Synopsis of Transactions Relating to Manufacturing and Prime Costs.
31. Synopsis of Transactions Relating to Warehouse, Stock and Sales.
32. Commercial Office (Orders and Invoices).
33. Stores.
34. Works and Job Office.
35. Warehouse.
36. Prime Cost and Ledger Clerk's Office.
37. Balancing and Accounts.
38. The Depreciation of Plant and Buildings.
39. Recording Plant and Buildings.
40. Foundry Accounts.
41. Forge Accounts.
42. Pattern Shop Accounts.
43. Salaries and Expenses.
44. Agents and Travelers.
45. Pupils.
46. Apprentices.
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48. Samples, Patterns, etc.
49. Miscellaneous.

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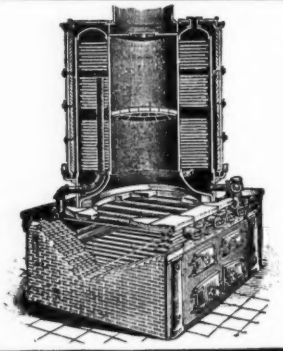

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Identity of Interest Dictates United Action by the Industrial Nations. Hon. John Barrett. 801
THE FOURTH ERA OF THE LEADVILLE MINING DISTRICT—
Stability and Prosperity Secured by Advanced Economical Methods. Thomas Tonge. 809
HEAVY MOTOR VEHICLES FOR ROAD SERVICE—
Design, Construction, and Performance of Leading British Types. Fred. W. Maynard. 825
COMMERCIAL REQUIREMENTS OF WATER-POWER GOVERNING—
Reliable Automatic Control Will Open a Vast Field for Small Plants. Elmer F. Cassel. 841
ELECTRIC MINING MACHINERY IN THE BRITISH COLLIERIES—
Lighting, Signaling, and the Working of Surface Arrangements. Sydney F. Walker. 847
THE CONTINUOUS RECORDING OF STEAM-ENGINE PERFORMANCE—
Simple, Constantly-Visible Records a Prime Factor in Engine Economy. W. Ripper. 867
LOCOMOTIVE EXHIBITS AT THE PARIS EXPOSITION—
Notable Evidences of Leading Tendencies in Modern Practice. Charles Rous-Marten. 877
COMMERCIAL ORGANIZATION OF THE MACHINE SHOP—
The Production Department. Execution of the Work. Hugo Diemer. 892

REVIEW OF THE ENGINEERING PRESS.

The British Press, 901 The Continental Press, 909 The American Press, 917

THE ENGINEERING INDEX.

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ARCHITECTURAL ENGINEERING, - - - - 927
CIVIL ENGINEERING, - - - - - - - 929
ELECTRICAL ENGINEERING, - - - - - - 934
GAS ENGINEERING, - - - - - - - - 941
MARINE AND NAVAL ENGINEERING, - - - - 942
MECHANICAL ENGINEERING, - - - - - 943
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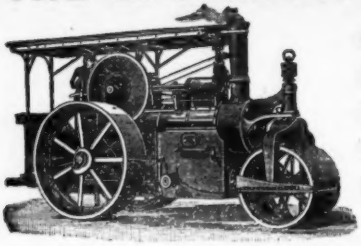

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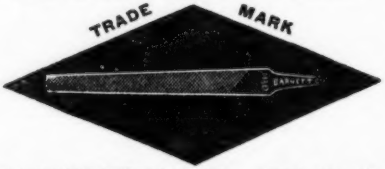

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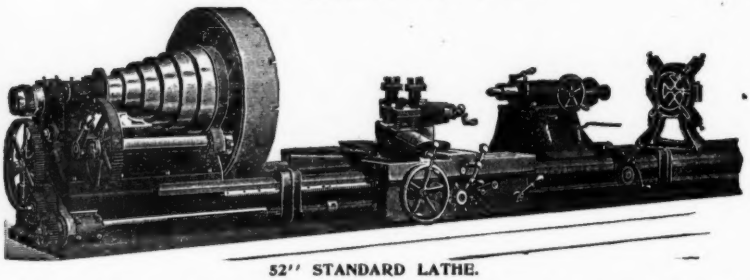

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